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NOLAN, DAVIS & ASSOCIATES

PRELIMINARY REPORT

Westray Stellarton
Pit Mine

Our File No.: H92561

Submitted to:

Nova Scotia Department of Environment
5151 Terminal Road, 5th Floor
Halifax, Nova Scotia B3J 3B7

by:

Nolan, Davis & Associates (N.S.) Limited
7020 Mumford Road
Halifax, Nova Scotia B3L 4S9

on behalf of
Westray Coal
A Division of Curragh Inc.

July 1992

93-01424/

NOLAN, DAVIS & ASSOCIATES (NS) LIMITED
ENGINEERS AND SCIENTISTS

7020 Mumford Road
Halifax, Nova Scotia
B3L 4S9
Telephone (902) 453-5555

P.O. Box 1021
Armdale P. Stn., N.S.
B3L 4K9
Fax (902) 453-6325
INET Nolan-Hfx

July 13, 1992

Mr. W.A. Coulter
Environmental Assessment Administrator
Nova Scotia Department of Environment
5151 Terminal Road, 5th Floor
Halifax, Nova Scotia
B3J 3B7

Dear Bill:

RE: Westray Stellarton Pit Mine Project

On behalf of Westray Coal, we are pleased to submit 25 copies of a Preliminary Report to address the Guidelines issued by your Department on May 28, 1992.

Our study has determined that, with the proposed mitigative measures, there will be little or no long term impact to the physical environment and that significant benefits will accrue as a result of the of the project due to increased employment, economic infusion to the regional economy, return of the area to useable land and the ability of the Trenton Generating Station to again use low sulphur coal.

Yours very truly,

NOLAN, DAVIS & ASSOCIATES
(N.S.) LIMITED

Alan V. Bell, P.Eng.
Principal and General Manager

AVB:kjc

EXECUTIVE SUMMARY

Westray Coal proposes to develop and operate a surface coal mine of 950,000 tonne/year capacity in the MacGregor Avenue/Foster Avenue area of Stellarton, Pictou County, Nova Scotia. The rate of mining and scale of operation will be similar to those associated with the Bulk Sampling Program conducted in the area between mid-January and the end of April 1992.

The mine operations will consist of two pits, to be mined sequentially. The first will be the Foord Pit which will recover coal from the Foord seam only. The second will be the CT Pit which will mine the Cage and Third seams. This phased approach will allow the site to be progressively reclaimed so that on completion of the project, in a period of about three to six years, the entire area will be backfilled and recontoured. Approximately two million tonnes of coal will be recovered during the operation.

The operation will employ about 60 people on the site, plus an additional 42 at the Plymouth wash plant. The coal will be transported from the site using a fleet of eight 30 tonne trucks. The intensity of trucking will therefore be similar to that during the Bulk Sampling Program.

The existing surface water control and treatment system will provide immediate protection to the aquatic environment and will be extended in a phased fashion as the site develops.

The report describes the existing environment in terms of its geological setting; the atmospheric environment; surface water, including biology; hydrogeology; the terrestrial environment and the social environment. The Valued Environmental Components identified in the study are: the social environment, air quality, noise, groundwater and surface water quality. Considerable background data exists for each of these components. Each could be impacted significantly unless the proposed mitigative measures are applied.

Environmental mitigation will include the following:

- Reclamation of the entire site (which is currently unusable due to past mining practices) to provide an area suitable for recreational uses. A committee will be struck to advise the Company on the final configuration preferred by the community.

- Enlargement of the existing drainage control and treatment system so as to provide continued reliable protection of the aquatic environment. Erosion control measures will also be applied at the site.

- Continuous application of dust control measures including wetting of active surfaces, hydroseeding of all surfaces at final grade and stabilization of any surfaces temporarily inactive. Trucks leaving the site will be washed to prevent carry over of dust and mud onto the highway system.

- Noise will be mitigated by means of a buffer zone, by the fact that most of the equipment will be working below grade in the pit and by proper selection and maintenance of equipment sound suppression systems.

- The impact of the project on groundwater is not expected to affect local wells. This will be carefully monitored and if changes occur, Westray will provide compensation and an alternate source of water.

- Westray will purchase the homes of any neighbouring residents wishing to sell and will provide a compensation package to any residents remaining in the area. The Company will maintain the existing residents' Liaison Committee as well as an ongoing environmental monitoring program satisfactory to this committee and the regulatory agencies.

It is our professional opinion that, with these mitigative measures in place, the project will have only minor, if any, long-term negative environmental impacts. The land form of the area will obviously be seriously disrupted during the operation but will be reclaimed to useable land on a progressive basis. This, coupled with the employment and economic benefits which the project will provide to the area, are seen as major attributes of the project. Its development will also allow the Trenton Generating Plant to return to the use of low sulphur coal, thus reducing its effects on the atmospheric environment.

TABLE OF CONTENTS

				Page No.
EXECUTIVE SUMMARY				i
TABLE OF CONTENTS				
1.0	**DESCRIPTION OF PROJECT**			1
1.1	General			1
	1.1.1	Physical Features		2
	1.1.2	Construction Details		2
	1.1.3	Operation		3
		1.1.3.1	Equipment	4
		1.1.3.2	Employment	4
		1.1.3.3	Fuel and Lubricants and Chemicals	5
	1.1.4	Coal Transportation		6
1.2	Mine Operation			7
	1.2.1	General Description		7
	1.2.2	Foord Pit Operations		8
	1.2.3	CT Pit Operations		10
1.3	Reclamation			10
	1.3.1	Provisions of the Mineral Resources Act		11
	1.3.2	Reclamation Plan		14
1.4	Surface Drainage			16
	1.4.1	Erosion Control		18
1.5	Pit Wall Stability			18
1.6	Dump Stability			18
1.7	Fire and Explosion Hazard			19
	1.7.1	Methane		19
	1.7.2	Coal Dust		20
	1.7.3	Spontaneous Combustion		20
	1.7.4	Site Specific Hazards		21
2.0	**ENVIRONMENTAL SETTING**			25
2.1	Introduction			25
2.2	Geological Setting			25
	2.2.1	Physiography		25
	2.2.2	Surficial Geology		26
		2.1.2.1	Pedology	26
		2.1.2.2	Surficial Geology	27

TABLE OF CONTENTS

				Page No.
	2.2.3	Bedrock Geology		27
		2.2.3.1	Regional Stratigraphy	27
		2.2.3.2	Stellarton Group	28
		2.2.3.3	Bedrock of Proposed Site	30
2.3	Atmospheric Environment			30
	2.3.1	Climate		30
	2.3.2	Meteorology		31
		2.3.2.1	Temperature and Precipitation	31
		2.3.2.2	Winds	31
	2.3.3	Air Quality		33
		2.3.3.1	Regional Air Monitoring	34
		2.3.3.2	Total Suspended Particulates	34
		2.3.3.3	Polycyclic Aromatic Hydrocarbons (PAHs)	35
		2.3.3.4	Sulphur Dioxide	35
		2.3.3.5	Nitrogen Dioxide	36
		2.3.3.6	Carbon Monoxide	38
	2.3.4	Sound Levels		38
2.4	Surface Water Environment			40
	2.4.1	Hydrology		40
		2.4.1.1	Receptor Stream Designation	41
		2.4.1.2	Drainage Basin Morphology	41
		2.4.1.3	Channel Morphology	42
		2.4.1.4	River Basin Activities	43
		2.4.1.5	Water Flows	44
		2.4.1.6	Water Chemistry	45
	2.4.2	Sedimentology		46
		2.4.2.1	Erodability	46
	2.4.3	Sediment Geochemistry		47
	2.4.4	Aquatic Biology		47
		2.4.4.1	Overview	47
		2.4.4.2	Recreational Fisheries	49
		2.4.4.3	Fish Habitat	51
		2.4.4.4	Existing Habitat Impacts	52

TABLE OF CONTENTS

				Page No.
2.5	Hydrogeologic Setting			53
	2.5.1	Regional Hydrogeology		53
	2.5.2	Site Hydrogeology		55
		2.5.2.1	Overburden - Till Hydrostratigraphic Unit	56
		2.5.2.2	Bedrock - Stellarton Series Hydrostratigraphic Unit	57
	2.5.3	Hydrogeological Overview		60
2.6	Terrestrial Environment			61
	2.6.1	Overview		61
	2.6.2	Vegetation		62
		2.6.2.1	Forest Habitat	62
		2.6.2.2	Wetlands Habitats	63
		2.6.2.3	Sensitive Areas	64
	2.6.3	Wildlife		64
		2.6.3.1	Game Animals	65
		2.6.3.2	Non-game Animals	65
		2.6.3.3	Birds	65
	2.6.4	Land Use		66
2.7	Archaeological Resources			66
2.8	Social Environment			68
2.9	Overview of Existing Environment			69
	2.9.1	Valued Environmental Components		69
3.0	**ENVIRONMENTAL IMPACTS**			70
3.1	Air Quality			70
	3.1.1	Suspended Particulates		70
	3.1.2	Other Air Quality Impacts		71
3.2	Noise Impacts			71
	3.2.1	Impact Factors		71
3.3	Surface Water Impacts			73
	3.3.1	Physical & Chemical Impacts		73
	3.3.2	Surface Water Biological Impacts		74
	3.3.3	Spatial Zone of Influence		76
3.4	Potential Impacts to Groundwater			76

TABLE OF CONTENTS

			Page No.
3.5	Terrestrial Environmental Impacts		79
	3.5.1	Land Use Impacts	79
3.6	Archaeology		80
3.7	Social Impacts		80
3.8	Impacts at the Plymouth Site		81
4.0	**MITIGATIVE MEASURES**		82
4.1	Air Quality Mitigation		82
	4.1.1	Mining Operations	82
	4.1.2	On-site Vehicle Operations	82
	4.1.3	Wind Erosion of Waste Piles	83
	4.1.4	Carry Over Onto Highways	83
4.2	Noise Mitigation		84
4.3	Surface Water Mitigation		85
4.4	Hydrogeological Mitigation		85
4.5	Terrestrial Impact Mitigation		86
4.6	Social Mitigation & Compensation		87
	4.6.1	Compensation to Residents	87
		4.6.1.1 Property Purchase	87
		4.6.1.2 Start-up Compensation	88
		4.6.1.3 Ongoing Compensation	88
		4.6.1.4 Well Loss Compensation	88
	4.6.2	Compensation of Community	89
	4.6.3	Information to Residents	89
	4.6.4	Arbitration & Concilation	89
4.7	Summary of Residual Impacts		89
5.0	**PROPOSED MONITORING PROGRAM**		90

REFERENCES

LIST OF FIGURES

Figure 1-1 Site Location Map
Figure 1-2 Air Photo Imagery (1990) - Stellarton Pit Mine and Surrounding Areas

TABLE OF CONTENTS

Page No.

LIST OF FIGURES (Cont'd)

Figure 1-3	Site Topography, Stellarton Pit
Figure 1-4	Site Layout, Stellarton Pit
Figure 1-5	Foord Pit, Stage I Complete, Stellarton Pit
Figure 1-6	Foord Pit, Stage 2 Complete, Stellarton Pit
Figure 1-7	Waste Handling, Foord Pit Stage 1, Stellarton Pit
Figure 1-8	Waste Handling, Foord Pit Stage 2, Stellarton Pit
Figure 1-9	CT Pit, Stage 1 Complete, Stellarton Pit
Figure 1-10	CT Pit, Stage 2 Complete, Stellarton Pit
Figure 1-11	CT Pit, Stage 3 Complete, Stellarton Pit
Figure 1-12	Waste Handling, CT Mining, Foord Pit Reclamation Stellarton Pit
Figure 1-13	Waste Handling, CT Pit, Stages 2 and 3, Mining and Reclamation, Stellarton Pit
Figure 1-14	Final Reclamation Topography
Figure 1-15	Final Reclamation Potential Recreational Use
Figure 1-16	Stellarton Pit - Site Drainage System
Figure 1-17	Conceptual Water Balance for Treatment Ponds
Figure 2-1	Physiographic Regions of Pictou County
Figure 2-2	Stratigraphic Section of the Stellarton Group
Figure 2-3	Wind Rose for Westray Area (Abercrombie Point, Pictou County)
Figure 2-4	Ambient Air Monitoring Trends for Total Suspened Particulate
Figure 2-5	Noise and Dust Monitoring Stations, Stellarton Pit Mine
Figure 2-6	Common Indoor and Outdoor Noise Levels
Figure 2-7	Regional Hydrology
Figure 2-8	Trilinear Diagram, Major Ion Chemistry, Bear Brook/Middle River
Figure 2-9	Surface Water Monitoring Stations
Figure 2-10	Morphogenetic Regions and Yield Precipitation Relationships
Figure 2-11	Important Aquatic Resources
Figure 2-12	Stratigraphic Column
Figure 2-13	Borehole & Well Locations
Figure 2-14	Trilinear Diagram
Figure 2-15	Cross Section A-A'
Figure 2-16	Piezometric Surface from Hydrogeo (1981)
Figure 2-17	Trilinear Diagram of Pictou Group Waters
Figure 2-18	Terrestrial Vegetation
Figure 2-19	Environmentally Sensitive Areas
Figure 2-20	Archaeological Resources

TABLE OF CONTENTS

Page No.

LIST OF FIGURES (Cont'd)

Figure 4-1	Location of Proposed Monitoring Wells and Residences Utilizing Groundwater
Figure 4-2	Affected Properties
Figure 4-3	Summary of Residual Impacts

LIST OF TABLES

Table 1-1	Waste Movement
Table 1-2	Reclamation Material Volumes
Table 1-3	Summary of Calculated Pond Volumes
Table 1-4	Acid Generation Potential of Core Samples, Drillhole No.8 (NSDME, 1974), Stellarton Pit Mine
Table 1-5	Summary of Pond Discharge Data
Table 2-1	Climatology Summary
Table 2-2	Wind Speed Data, Pictou County
Table 2-3	Total Suspended Particulate (Dust) Monitoring, Stellarton Pit Mine
Table 2-4	Suspended Particulate Sampling Data Statistics
Table 2-5	Noise Monitoring Summary, Average Leq
Table 2-6	Bear Brook Water Quality Monitoring Data/Bulk Sampling Program
Table 2-7	Ambient Trend Water Quality Monitoring Data, Bear Brook/Middle River
Table 2-8	Water Chemistry for Middle River at Rocklin
Table 2-9	Stream Sediment Geochemistry Data Bear Brook
Table 2-10	Electrofishing Results for Bear Brook, Pictou County May 22, 1992
Table 2-11	Analysis of Yields in Various Hydrostratigraphic Units in Pictou County
Table 2-12	Mean Concentrations of Water Quality Data
Table 2-13	Hydraulic Data from K-Tests at Plymouth Mine Site
Table 2-14	Westray Groundwater Chemistry Data
Table 2-15	Stellarton Group Deep Hydrogeologic Test Results
Table 2-16	Groundwater Chemistry
Table 2-17	Comparison 1980 and 1992 Residential Well Water Quality Data
Table 2-18	Site Vegetation
Table 3-1	Potential Operational Phase Impacts before Mitigation
Table 3-2	Potential Reclamation Phase Impacts before Mitigation

TABLE OF CONTENTS

Page No.

LIST OF APPENDICES

Appendix 1	Flocculent Material Safety Data Sheets
Appendix 2	Water Quality Data from Domestic Wells
Appendix 3	Public Attitude Survey

PART ONE

DESCRIPTION OF THE PROJECT

1.0 DESCRIPTION OF THE PROJECT

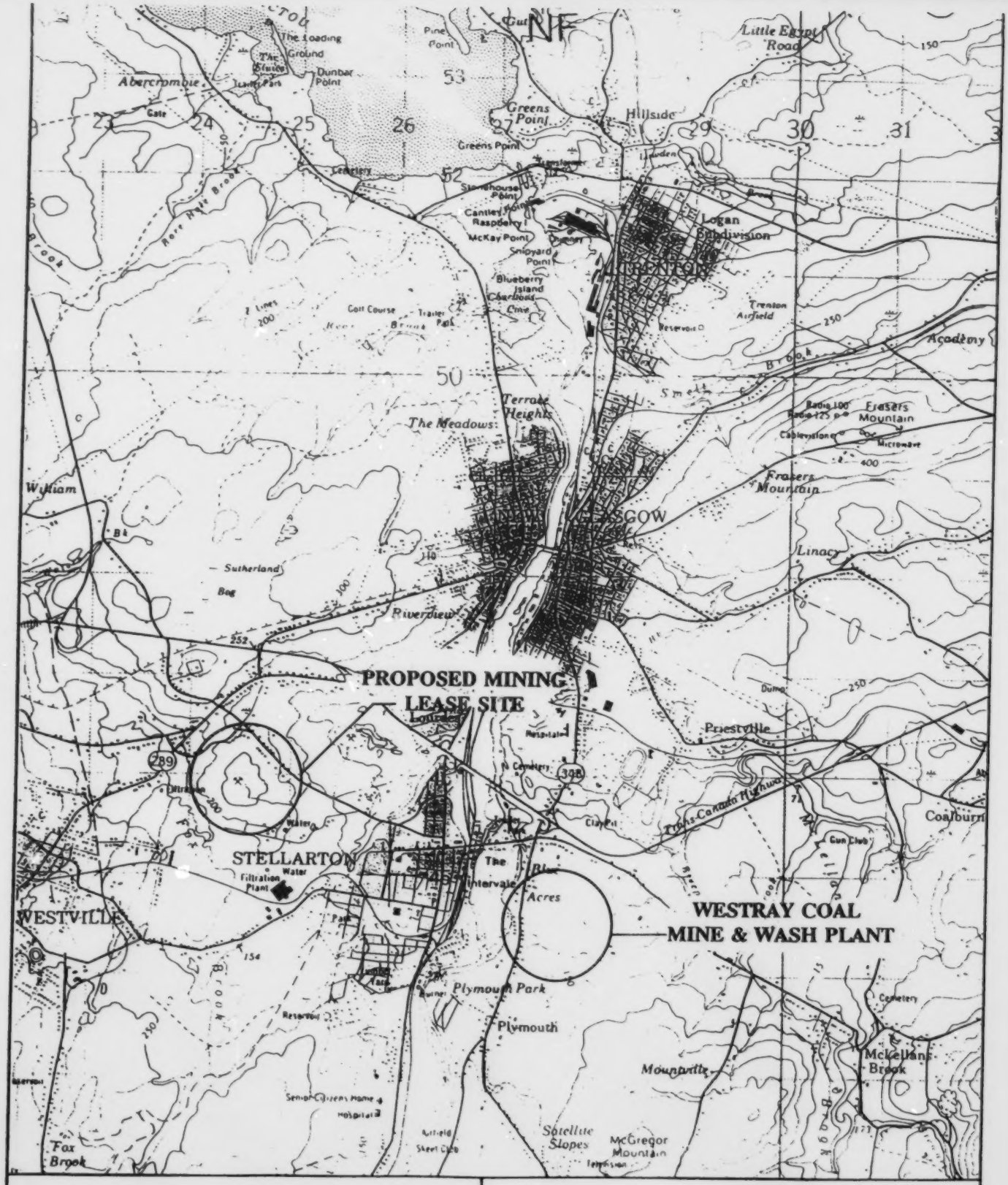
1.1 General

Westray Coal proposes to develop and operate a surface coal mine of 950,000 tonne per year capacity in the MacGregor Avenue/Foster Avenue area of Stellarton, Pictou County, Nova Scotia (see Figures 1-1, 1-2, 1-3 and 1-4).

The activities and scale of operation associated with the project will be similar in principle to those associated with the Bulk Sampling Program conducted in the area between mid-January, 1992 and the end of April, 1992, during which 100,000 tonnes of raw coal were mined and trucked to Westray's Plymouth plant. The rate of production during the final weeks of the Bulk Sampling Program were similar or slightly greater than those proposed at 950,000 tonnes per year (i.e. a peak of 3840 tonnes/day during the Bulk Sampling Program as compared to 3167/day tonnes proposed - see Section 1.1.4).

The project will contribute to the development of Westray's resource base in the area around the existing coal preparation plant. The proposed mine will provide an alternative source of supply while the underground Plymouth mine is being rehabilitated and will also enable the Company (Westray) to bid on the outside market for lot items of coal as opportunities occur.

The proposed mining area contains reserves of approximately 7.2 million tonnes in six significant seams to a depth of 120 metres below surface. However, the recoverable reserves that could be mined by open pit methods are estimated to be 2.1 million tonnes. At a production rate of 950,000 tonnes per year, the project could therefore extend for a minimum of two years. Depending on the time it takes to re-establish production of the Plymouth mine, it is possible that production of the proposed Stellarton Pit Mine will be phased down to a level of 200,000 tonnes per year, thus extending the life of the mine to go up to six years.


PROPOSED MINING LEASE SITE
WESTRAY COAL MINE & WASH PLANT
STELLARTON
WESTVILLE
Trans-Canada Highway
Priestville
Coalburn
Plymouth Park
Plymouth
Mountville
McLellans Brook
Fox Brook
Satellite Slopes
McGregor Mountain
Fraser's Mountain
Terrace Heights
The Meadows
Riverview
Sutherland Bog
Greens Point
Hillside
Logan Subdivision
Trenton Airfield
Academy
Linacy
Little Egypt Road
Abercrombie
Dunbar Point
Pine Point
Blueberry Island
Cantley Raspberry I.
McKay Point
Snoyard Point
Stonehouse Point
Golf Course
Trailer Park
Filtration Plant
Water
Cemetery
Hospital
Gun Club
Clay Pit
Reservoir
Senior Citizens Home
Mitfield
Skeet Club
Cablevision
Micromart
Radio 100
Radio 125
Dump
Tailings Pond
Acres
Intervale
Park
Brook
Creek
Lines
Lookout
Tower
Ruins
Cemetery
Mountain
Pond
Bog
Marsh
Swamp
Gut
Cove
Point
Road
Ground
Loading
Gate
Trailer Park
Golf Course
Trailer Park
Reservoir
Cemetery
Hospital
Gun Club
Clay Pit
Water
Filtration Plant

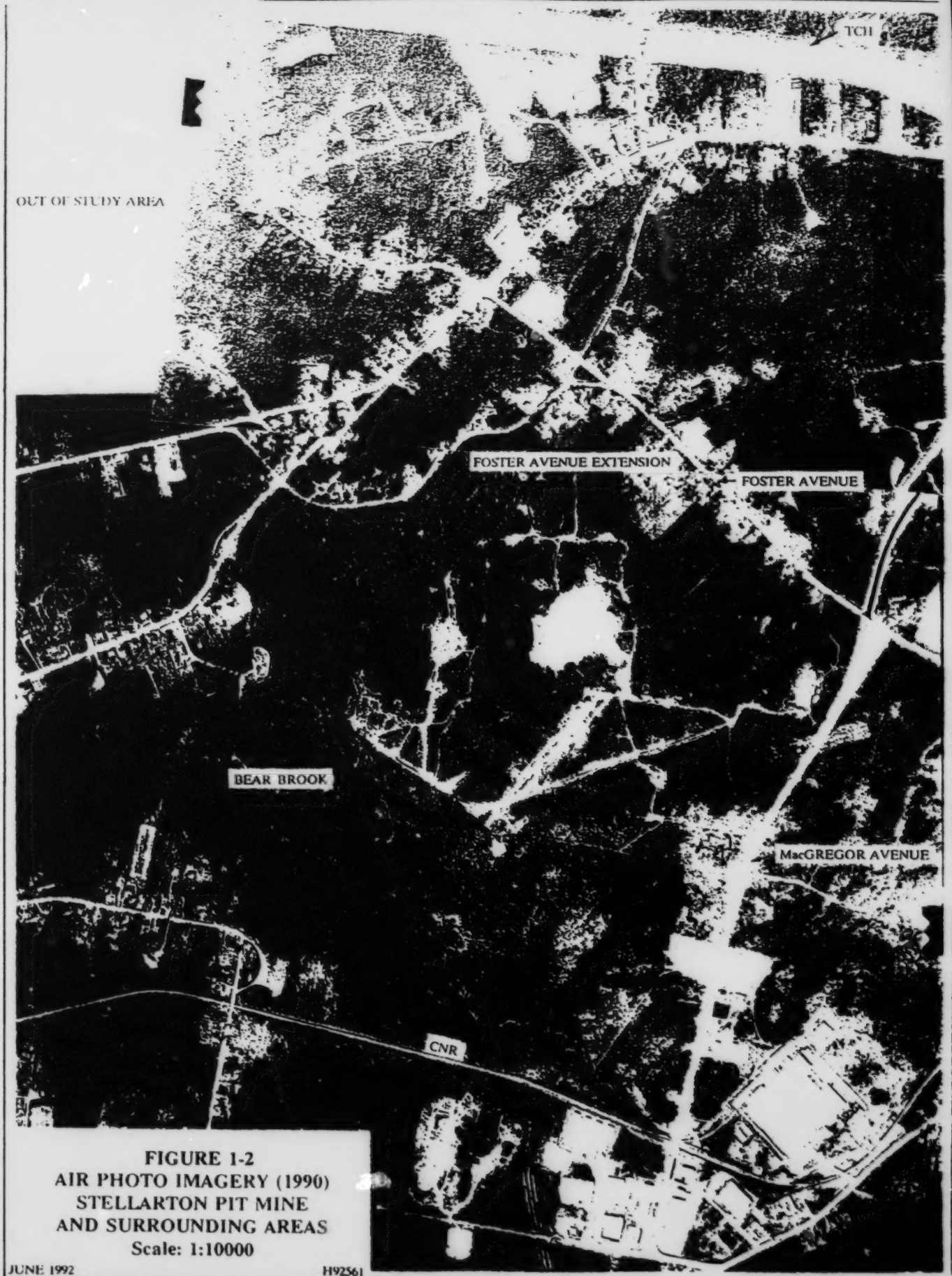
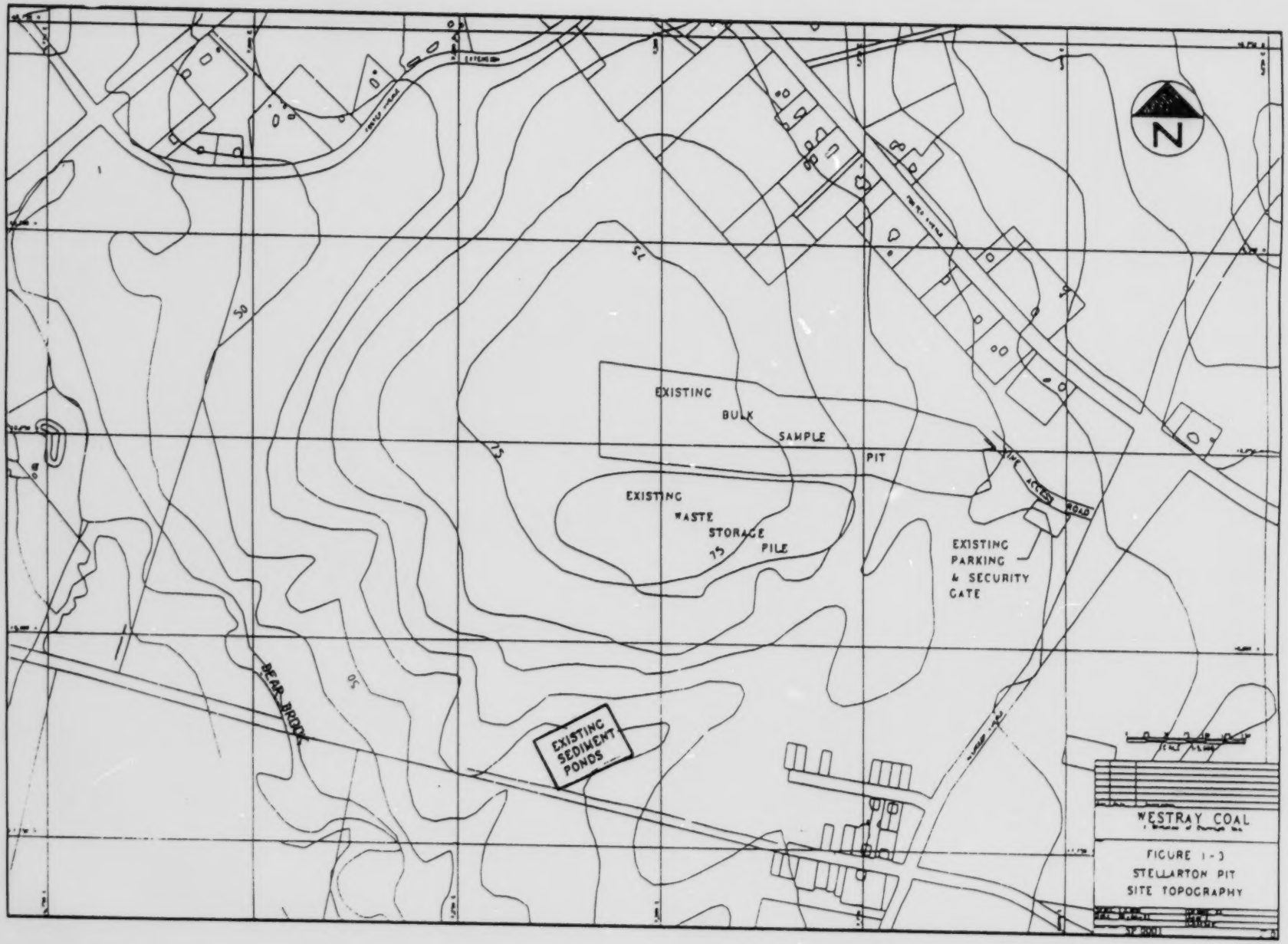
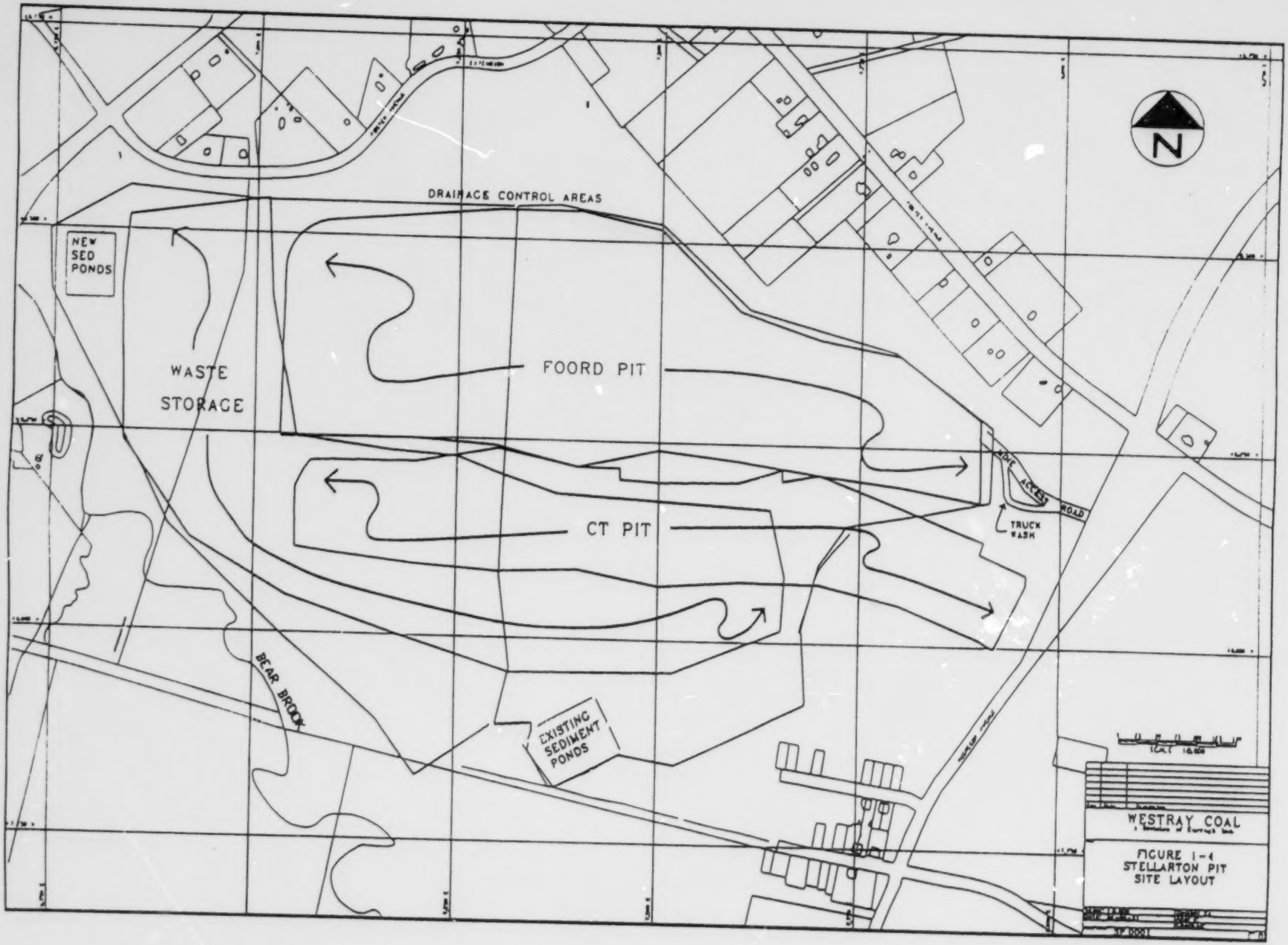


FIGURE 1-2
AIR PHOTO IMAGERY (1990)
STELLARTON PIT MINE
AND SURROUNDING AREAS
Scale: 1:10000

JUNE 1992 H92561


N
EXISTING
BULK
SAMPLE
PIT
EXISTING
WASTE
STORAGE
PILE
EXISTING
PARKING
& SECURITY
GATE
ACCESS ROAD
BEAR BROOK
EXISTING
SEDIMENT
PONDS
WESTRAY COAL
FIGURE 1-3
STELLARTON PIT
SITE TOPOGRAPHY


N
DRAINAGE CONTROL AREAS
NEW SED PONDS
WASTE STORAGE
FOORD PIT
CT PIT
SITE ACCESS ROAD
TRUCK WASH
BEAR BROOK
EXISTING SEDIMENT PONDS
WESTRAY COAL
FIGURE 1-4
STELLARTON PIT
SITE LAYOUT

The area also contains significant reserves at depths greater than 120 metres. These reserves could be mined underground with access from the open pit areas after the surface reserves have been exploited, giving longer life to the project. Underground mining is not included in the scope of this proposal and no approval for underground mining is being sought. Should Westray wish to propose any new underground mining, that project will be registered and assessed as a separate undertaking under the Environmental Assessment Act.

1.1.1 Physical Features

The proposed development is situated in an area of approximately 50 hectares as shown in Figure 1-4. The major physical features associated with the development of the mine will be as follows:

- two open pits, generally located within the boundaries shown on Figure 1-4. This will enable the mine to be operated with progressive reclamation of the mined out pits as described in Section 1.3.
- one or more waste storage piles, also generally located within the boundary indicated on Figure 1-4.
- truck wash station.
- security station.
- mine and surface water collection system involving ditching and treatment ponds based on the existing facilities but modified as mining progresses. The proposed system is described in Section 1.4.

1.1.2 Construction Details

The construction of the mine and associated infrastructure is planned to commence in the summer of 1992. Once approval is obtained, the following activities will be undertaken as a function of the construction phase:

- Detailed review of permit requirements with the Liaison Committee
- Fencing of the entire operations site

- Development of the Stage I Foord Pit as described in Section 1.2.

- Modification of existing waste water collection and treatment facilities to address future requirements as described in Section 1.4.

- Negotiation of compensation and/or purchase of required properties are currently ongoing and will continue

A distinct advantage of the proposed undertaking is that it will impose only minor incremental impacts to the environment as compared to the recent Bulk Sampling Program and both the waste control and the environmental monitoring systems currently in place will be maintained through the development phase.

1.1.3 Operation

Details of the mine plan, to the extent they are currently developed, are described in Section 1.2. In general terms, mining operations will involve the extraction of coal by conventional open pit mining methods, except that blasting will not be used. Waste rock or overburden will be loaded on to 45 tonne off-road trucks and hauled to the waste storage or reclamation areas. Run of mine (ROM) coal will be hauled to the Westray plant in Plymouth for washing and shipment to customers. There will be no crushing or other processing at the Stellarton site. The Plymouth coal preparation plant is fully operational and will use existing facilities and the same processes as those in operation prior to the underground mine accident. Similarly, the existing coal handling and rail loadout facilities will also be used in the shipment of the product.

If the necessary permits can be obtained, production of coal will commence in the summer of 1992, at the same time as the mine and infrastructure are being developed. Because the coal is already exposed at surface, full production will begin almost immediately.

As previously stated, the mine could operate for a period of at least two years based on a production rate of 950,000 tonnes per year and pit reserves of 2.1 million tonnes.

This could be extended for up to six years depending on the time it takes to re-establish the Plymouth mine.

1.1.3.1 Equipment

Equipment requirements will vary through the life of the project. In particular, the numbers and types of equipment being used will be quite different during reclamation work than during mining work. Also, the numbers of trucks required for both the waste and coal hauls will increase as the pit deepens; this is a reflection of the increased time required for the trucks to travel out of the pit.

Following is a list of the anticipated equipment requirements working at the Stellarton site:

Excavators	5
Trucks (waste haul)	14
Trucks (coal haul)	8
Loaders	2
Dozers	7

In addition, there will be other service equipment at the site, such as: water trucks, graders, tandem trucks, pickups, etc.

1.1.3.2 Employment

The anticipated workforce at the site is as follows:

Equipment Operators	33
Labourers	5
Maintenance	3
Survey	3
Security	4

Supervisors	4
Truck drivers (coal)	8
Total	60

This figure is based on a six day work week with 12 hours worked each of these days. Discussions are currently being held with local residents about the relative merits of working a five day week but using two eight hour shifts for a total of 16 hours per day. Using two shifts would almost double the number employed at the site. Discussions are still ongoing and will be reported to the Department of Environment once the preferred approach is agreed by all parties concerned.

The work will enable the re-employment of many Westray employees who have been laid off. The anticipated Westray workforce that will benefit from continued employment as a result of the project are as follows:

Plant operations	16
Plant maintenance	6
Supervisor/technical	6
Laboratory	4
Administration/clerical	6
Total	42

1.1.3.3 Fuel, Lubricants and Chemicals

There will be no permanent maintenance facilities for equipment at the site. Trucks and other equipment will be fuelled by mobile tanker truck as during the Bulk Sampling Program. Similarly there will be no on-site storage of lubricants and solvents other than the small quantities used for daily routine checks which are normally kept on each vehicle or a small service truck.

Any accidental hydrocarbon leaks or spills would therefore be small and will be contained within the drainage control system on the site.

The only other chemicals to be used on-site will be the flocculants required for water treatment (see Section 1.4). These will be stored off-site by the treatment contractor and only immediate needs brought to the pond areas.

1.1.4 Coal Transportation

It is proposed to transport the run of mine (ROM) coal from the mine without crushing or screening, using a fleet of eight 30 tonne trucks. The operation will be very similar in its scale and intensity to that used for the Bulk Sampling Program. During that program the average quantity trucked was 2436 tonnes/day calculated on a monthly basis. On a weekly basis the peak was 3408 tonnes/day and the highest single day was 3840 tonnes which comprised 128 truck loads.

Based on a schedule of 6 days per week, 12 hours per day, and allowing for 12 holidays or other stoppages, there will be 301 days per year on which coal will be trucked. For an annual rate of 950,000 tonnes per year, the rate will be 3167 tonnes per day, or 106 loads per day for a fleet of six to eight 30 tonne trucks. The cycle time for each truck will therefore average 41 minutes for loading, unloading and the return trip between Stellarton and Plymouth, a figure that was easily achieved during the Bulk Sampling Program. If a 5 day, 16 hours per day regime is opted for, the daily rate will be 3815 tonnes per day or 127 loads over 16 hours, which is an average 45 minutes per cycle.

Trucks moving between the Stellarton site and the Plymouth Plant will leave the site by MacGregor Avenue onto the Highway 289 and the TransCanada Highway 104, then using Highway 348 to enter the Westray Plant in Plymouth. The reverse will apply for the returning empty trucks. Truck drivers will be required to strictly maintain speed limits and other traffic regulations as was the case for the Bulk Sampling Program. The processed coal leaving the Plymouth Plant will be transported by rail using the existing facilities.

It is very unlikely that any other forms of coal transportation will apply during the life of the mine although if it were to be extended for any reason, it would be feasible to consider shipping coal directly from the site by rail. It would be possible to construct a spurline onto the site from the existing track with a loadout facility at the site. This, however, is not contemplated.

Occasional direct trucking of ROM coal from the site to the Trenton plant is a possibility but will likely occur very infrequently due to Nova Scotia Power Corporation (NSPC) preference for delivery by rail. Should this occur the route would be MacGregor Avenue to Highway 289, to the Trans Canada Highway 104, to the Trans Canada Highway 106, to the Abercrombie Connector, a branch of Highway 106, to the generating station at Trenton.

1.2 Mine Operations

1.2.1 General Description

The mine operations will consist of two open pits, mined sequentially. The first pit to be mined is the Foord Pit which will recover coal from the Foord seam only. The CT Pit will subsequently mine the Cage and Third seams. Figure 1-4 shows the location of the two pits, as well as the waste storage area.

In general, the mining sequence will consist of the following operations:

1. Waste will be excavated from above the coal seam by the use of hydraulic excavators and loaded onto off-road trucks (45 tonne rated capacity). The waste will be hauled out of the pit to a waste storage area. The rock overlying the seams are predominantly shales which can readily be dug by the excavators. Some of the rock will need to be ripped with large (500 HP) dozers. No blasting will be done at the site.

2. The coal will be mined using hydraulic excavators, and loaded onto highway trucks for haulage to the Westray plant site in Plymouth. There will be no crushing or other processing (e.g. screening) of the coal at the Stellarton site.

3. At the completion of mining, the pit will be reclaimed by moving the waste back into the excavated pit. This work will be accomplished both by truck and excavator operations as well as by dozing the material back into the pit. Dozing of the material back into the pit could involve the use of large (500 HP) dozers.

The mining will be carried out in five metre benches. That is, the waste and coal will be mined in horizontal slices five metres thick. Typically, the pit walls will be mined to the coal footwall (the undisturbed rock lying immediately below the coal seam) on the south side of the pit. On the other sides of the pit, the walls will be built in rock with an overall slope angle of between 45° and 65°. These highwalls will have a safety berm every 15 metres, which will catch any loose rock which might come down off the slope.

The mining will be carried out sequentially, that is mining will be nearly completed in the Foord Pit before beginning in the CT Pit. In order to provide a constant coal flow out of the pit, there will be some overlap of mining in the two pits at the same time. Mining will continue in the second pit while reclamation is underway in the first pit.

The sequence of mining operations, as well as the extent of the pits and waste dumps, and the haul routes, are described fully in the following sections:

1.2.2 Foord Pit Operations

The Foord Pit will be the first pit to be mined. The Foord Pit will be a continuation of the pit mined in the Bulk Sampling Program from early 1992. The physical characteristics of the pit are as follows:

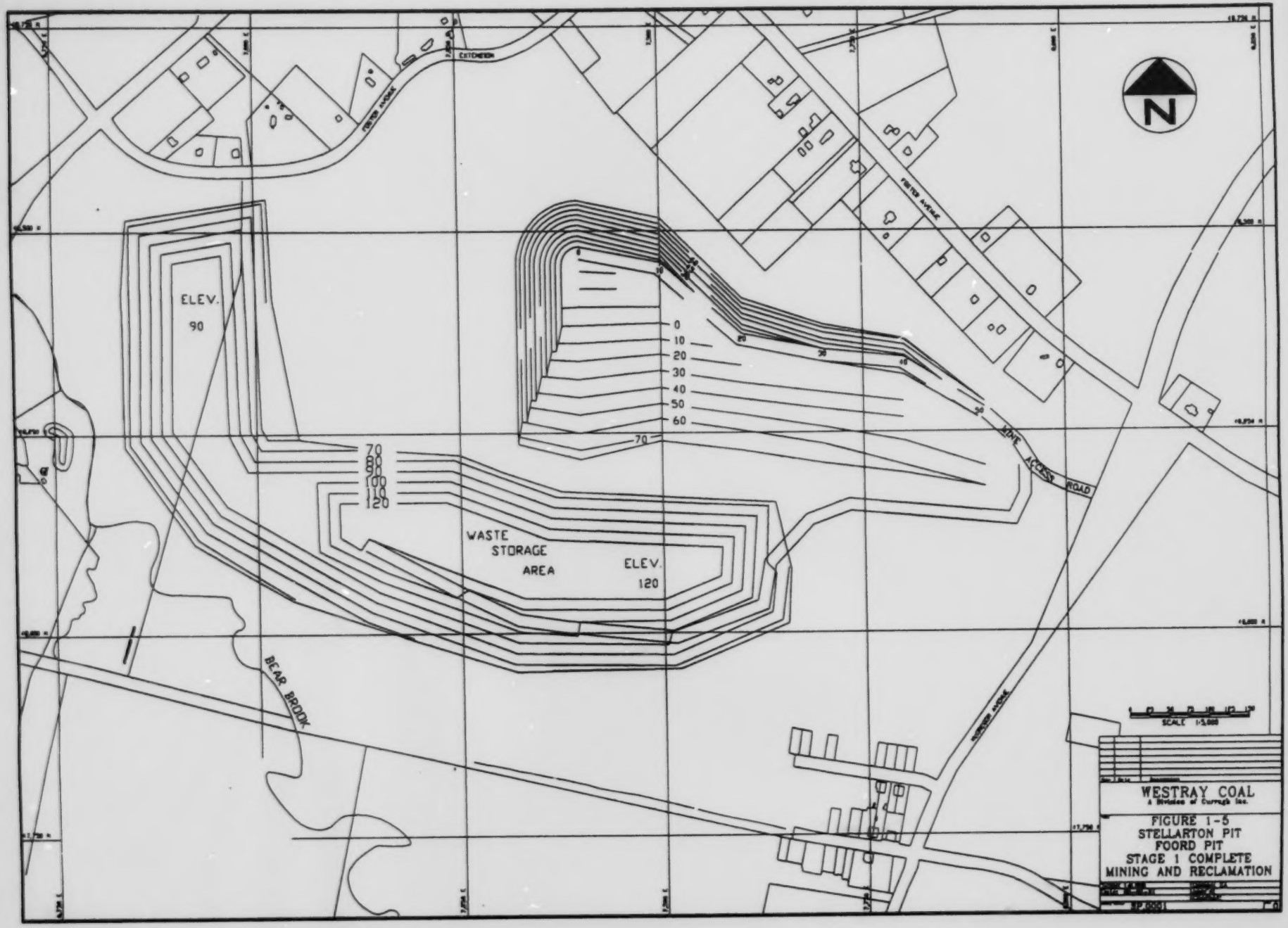
Length	900 metres
Width (maximum)	300 metres
Depth (maximum)	90 metres
Coal to be mined	1.7 million tonnes
Waste to be mined	7.3 million bank cubic metres (BCM)

The Foord pit will be mined in two stages. During the first stage, 1.0 million tonnes of coal and 3.6 million BCM of waste will be mined. Figure 1-5 shows the pit status at the completion of the stage 1 pit. The pit will be developed to elevation 0 (75 metres below original ground elevation), with access into the pit from a ramp built into the north wall. Waste from the stage 1 pit will be stored in the dumps located south and west of the pit limits, as shown on Figure 1-5.

The stage 2 pit contains 0.7 million tonnes of coal and 3.7 million BCM of waste. To access the upper benches of the stage 2 pit, fill will be placed on the south side of the stage 1 pit, providing new temporary ramp access to stage 2. This system of ramps will provide access to the pit at elevation 10; from that point on, the existing stage 1 ramp will be continued down the north pit wall, providing access to the -20 elevation. Of the 3.7 million BCM of waste to be mined from the stage 2 pit, 0.8 million BCM will be used to construct the in-pit ramps to the 20 elevation. A further 1.2 million BCM will be backfilled into the pit once the ramp access to upper benches is no longer required. Figure 1-6 shows the Foord Pit status at the completion of stage 2 mining.

Table 1-1 details the waste movement out of both stages of the pit. The sequence of waste movement during the Foord Pit operations is shown in Figures 1-7 and 1-8.

Reclamation of the Foord Pit will begin immediately after completion of mining. (See Section 1-3).


N
ELEV.
90
0
10
20
30
40
50
60
70
80
90
100
110
120
WASTE
STORAGE
AREA
ELEV.
120
MINE ACCESS ROAD
BEAR BROOK
WESTRAY COAL
A Division of Curragh Inc.
FIGURE 1-5
STELLARTON PIT
FOORD PIT
STAGE 1 COMPLETE
MINING AND RECLAMATION

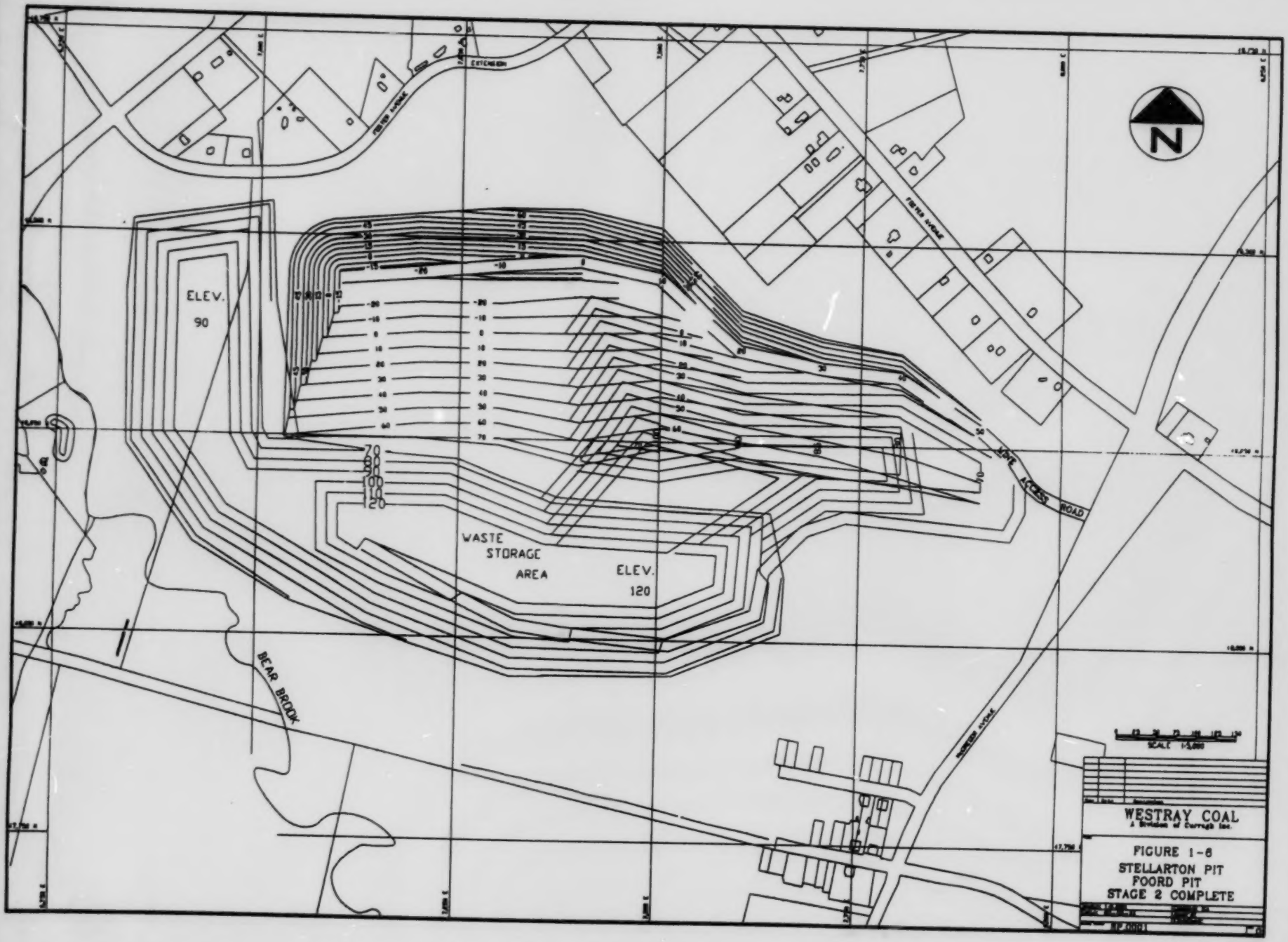

N
ELEV.
90
WASTE
STORAGE
AREA
ELEV.
120
BEAR BROOK
MINE ACCESS ROAD
WESTRAY COAL
A Division of Curragh Inc.
FIGURE 1-6
STELLARTON PIT
FOORD PIT
STAGE 2 COMPLETE

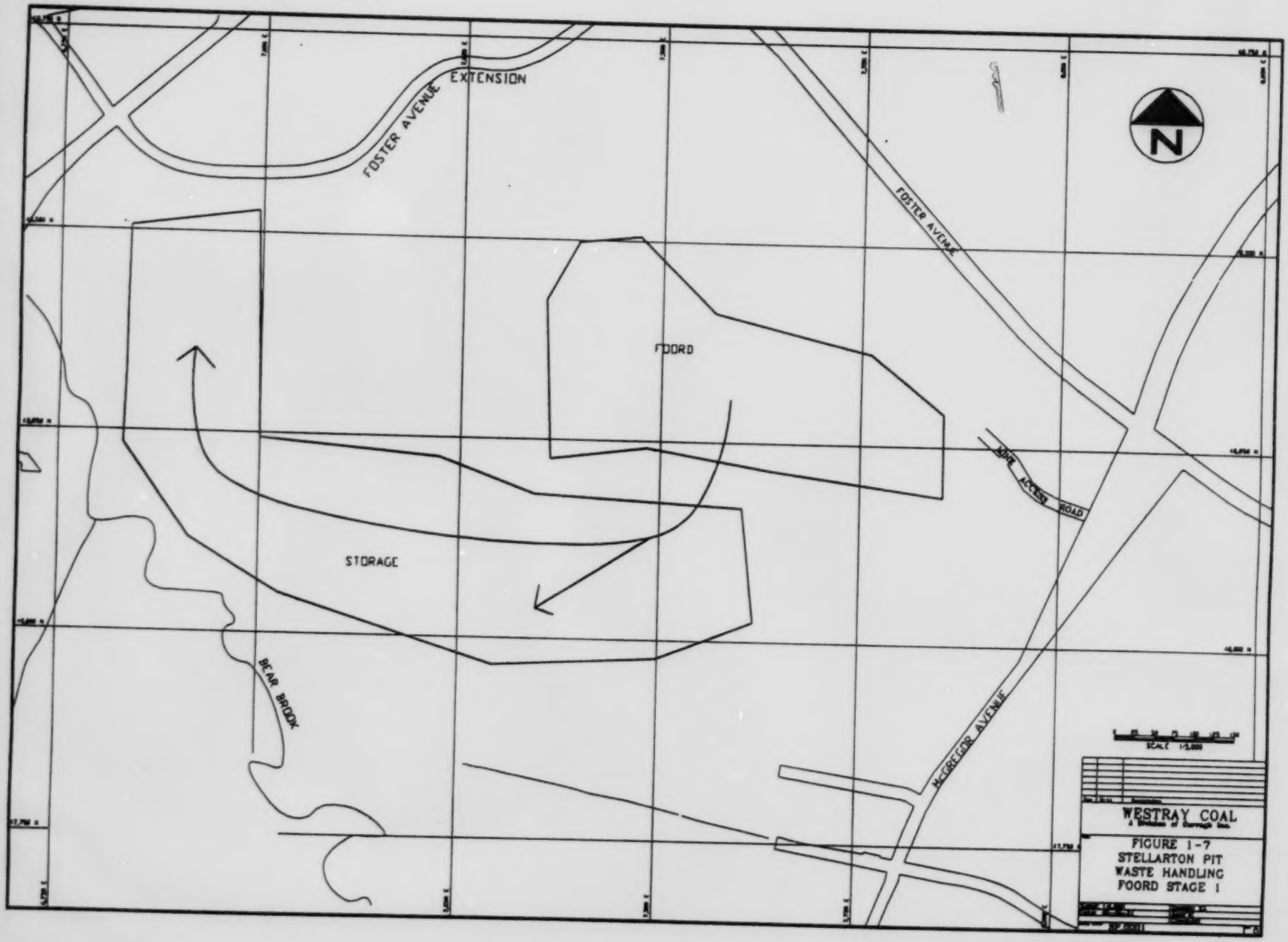
TABLE 1-1

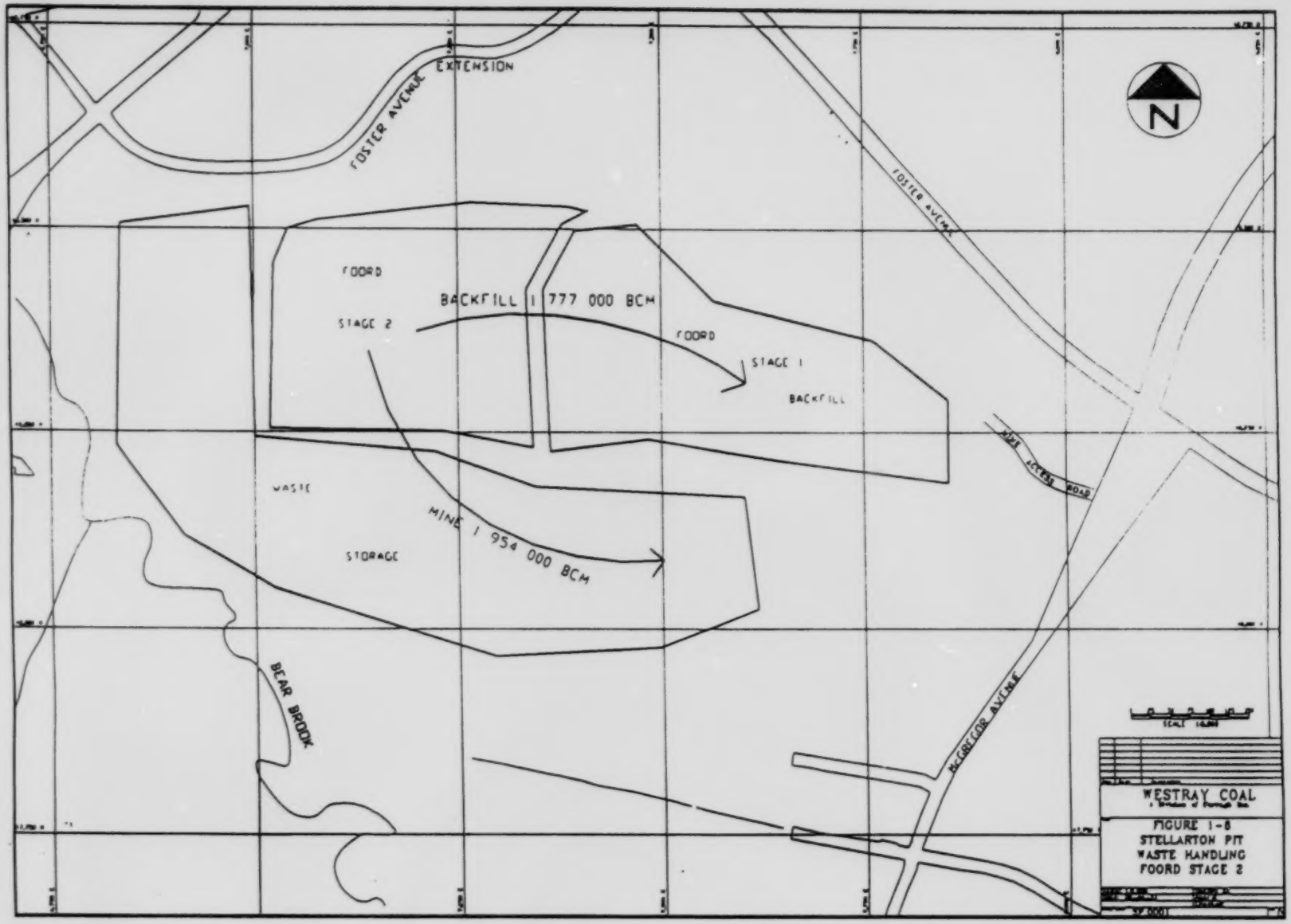
Waste Movement
Quantities in Thousands of Bank Cubic Metres

Source	Destination	Mined Volume	Backfilled Volume
Foord Pit Stage 1	Waste Dump	3,615	0
Foord Pit Stage 2	Waste Dump	1,954	0
Foord Pit Stage 2	Foord Pit Stage 1	1,777	1,777
Waste Dump	Foord Pit Stage 1/2	0	5,099
CT Pit Stage 1	Foord Pit Stage 1/2	470	470
CT Pit Stage 2	CT Pit Stage 1	498	498
CT Pit Stage 3	CT Pit Stage 1	557	557
Waste Dump	CT Pit Stage 3	0	470
	Total Waste Movement	8,871	8,871

Mined volume = volume of waste mined in uncovering coal

Backfilled Volume = volume of waste moved into excavated area, either from mining area or from waste dump


FOSTER AVENUE EXTENSION
FOSTER AVENUE
FOORD
STORAGE
MINE ACCESS ROAD
BEAR BROOK
McGREGOR AVENUE
N
WESTRAY COAL
FIGURE 1-7
STELLARTON PIT
WASTE HANDLING
FOORD STAGE 1


FOSTER AVENUE EXTENSION
FOSTER AVENUE
N
FOORD
STAGE 2
BACKFILL 1 777 000 BCM
FOORD
STAGE 1
BACKFILL
AIR ACCESS ROAD
WASTE
STORAGE
MINE 1 954 000 BCM
BEAR BROOK
MCGREGOR AVENUE
WESTRAY COAL
FIGURE 1-8
STELLARTON PIT
WASTE HANDLING
FOORD STAGE 2

1.2.3 CT Pit Operations

The CT Pit will mine the Cage and Third seams. The physical characteristics of this pit are as follows:

Length	900 metres
Width (maximum)	150 metres
Depth (maximum)	25 metres
Coal to be mined	0.4 million tonnes
Waste to be mined	1.5 million BCM

The CT Pit will be mined in three successive stages, each with an independent ramp system, allowing successive stages to be backfilled entirely into the preceding stages. The sequence is shown in Figure 1-9, 1-10 and 1-11.

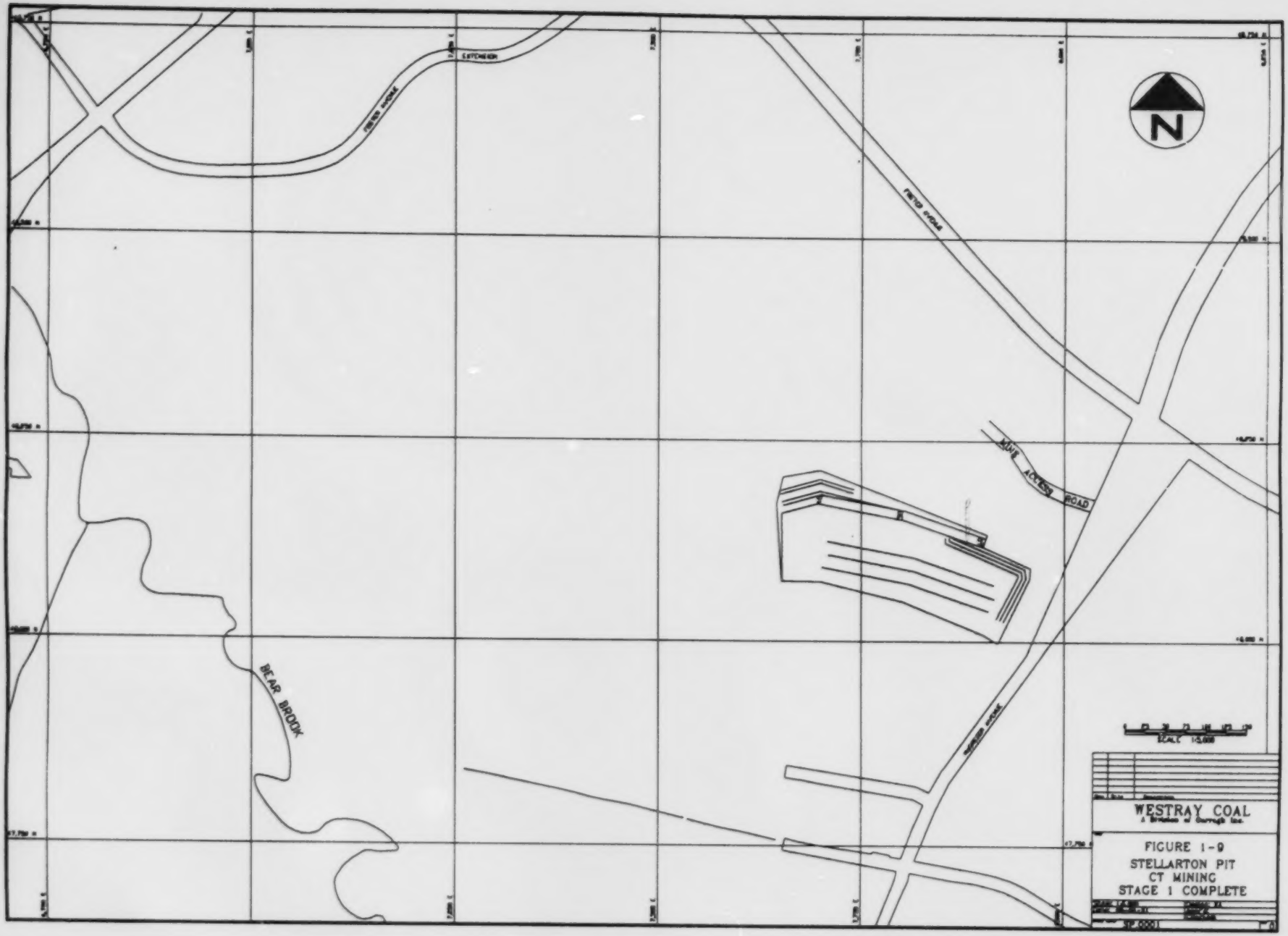
Table 1-1 details the waste movement for the CT Pit, and is shown diagramically in Figures 1-12 and 1-13.

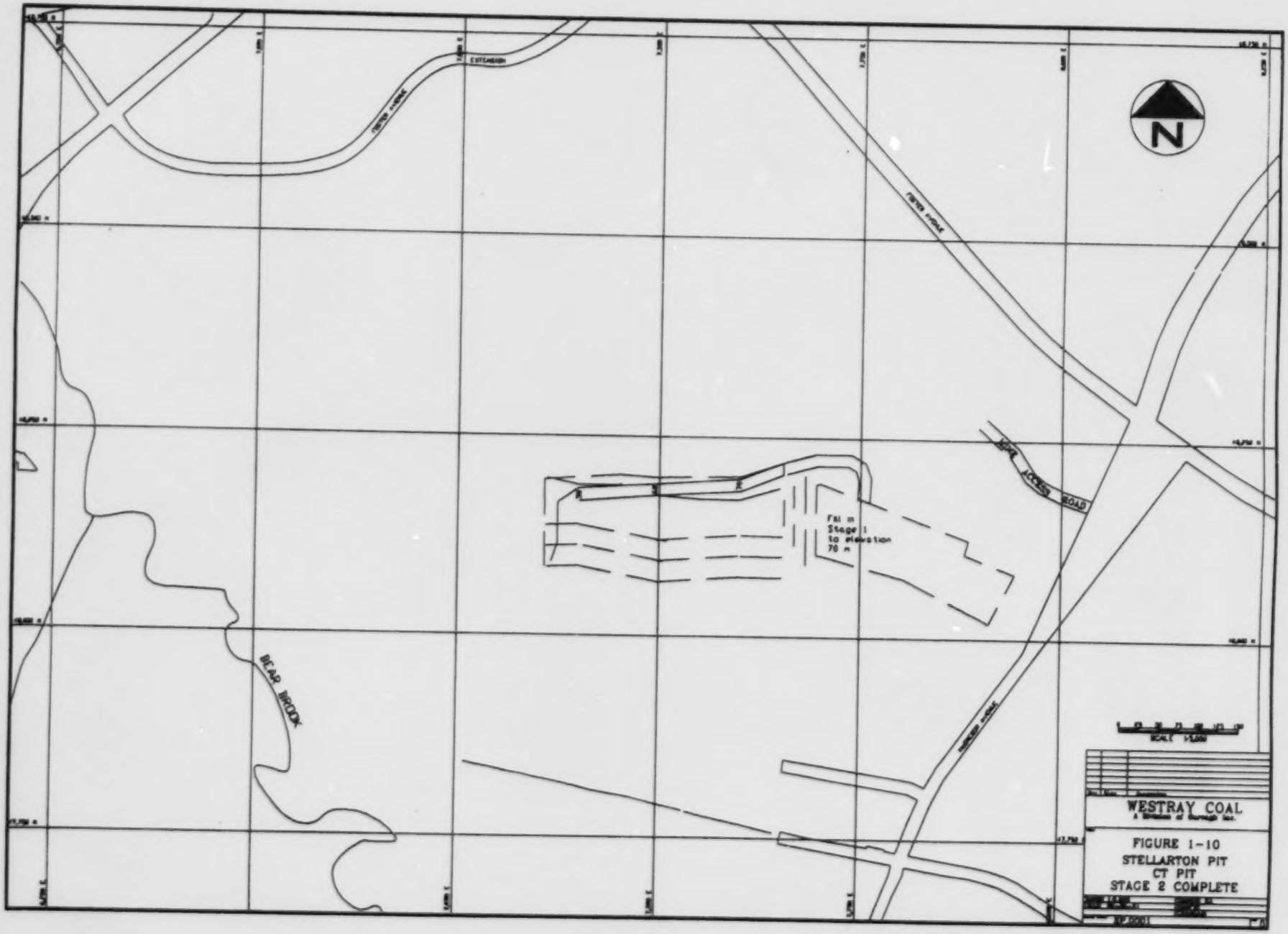
Reclamation of the CT pit is progressive in that stages 1 and 2 will be partially reclaimed during mining. Full reclamation will begin once mining is complete (see Section 1.3).

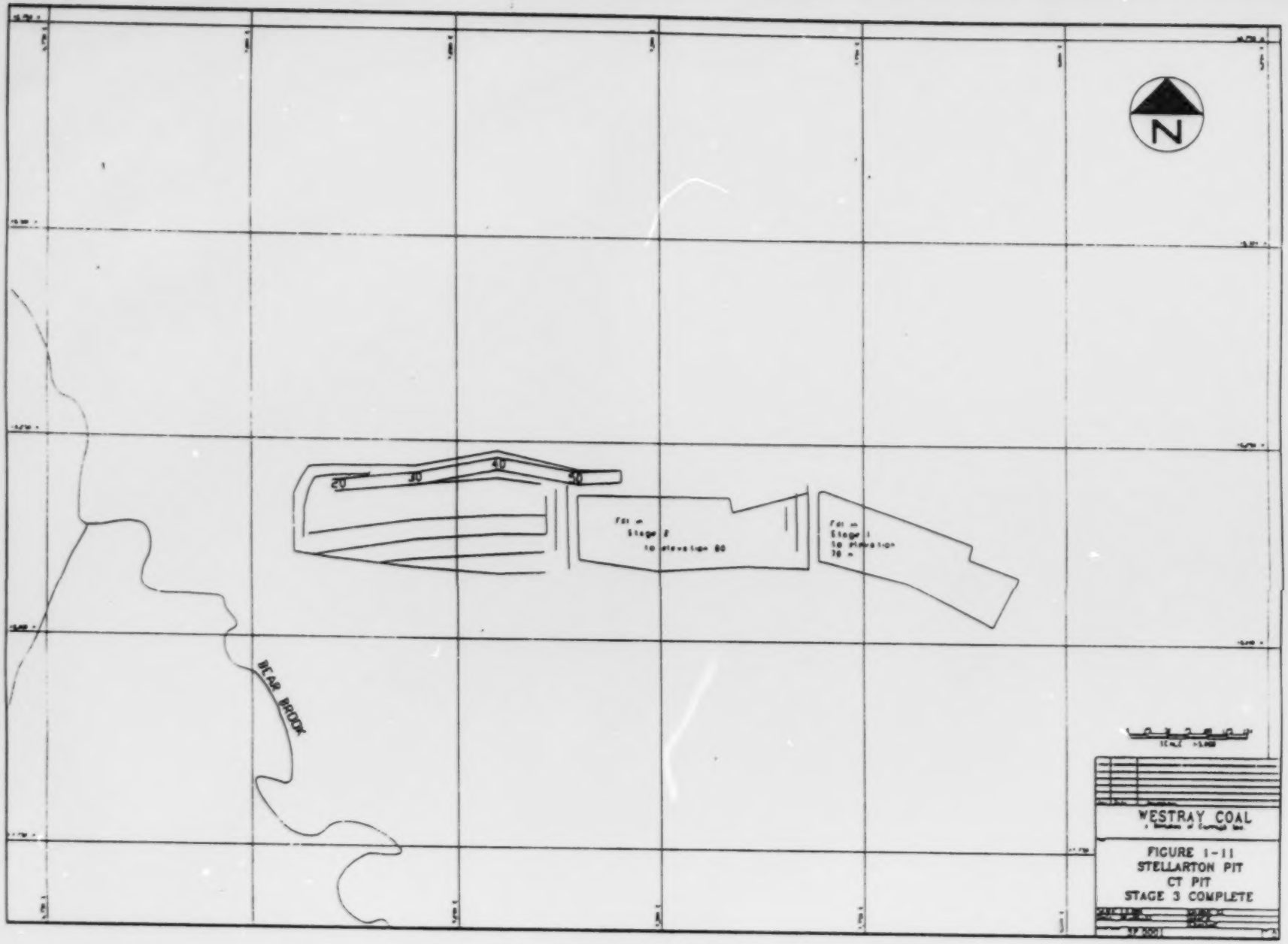
1.3 Reclamation

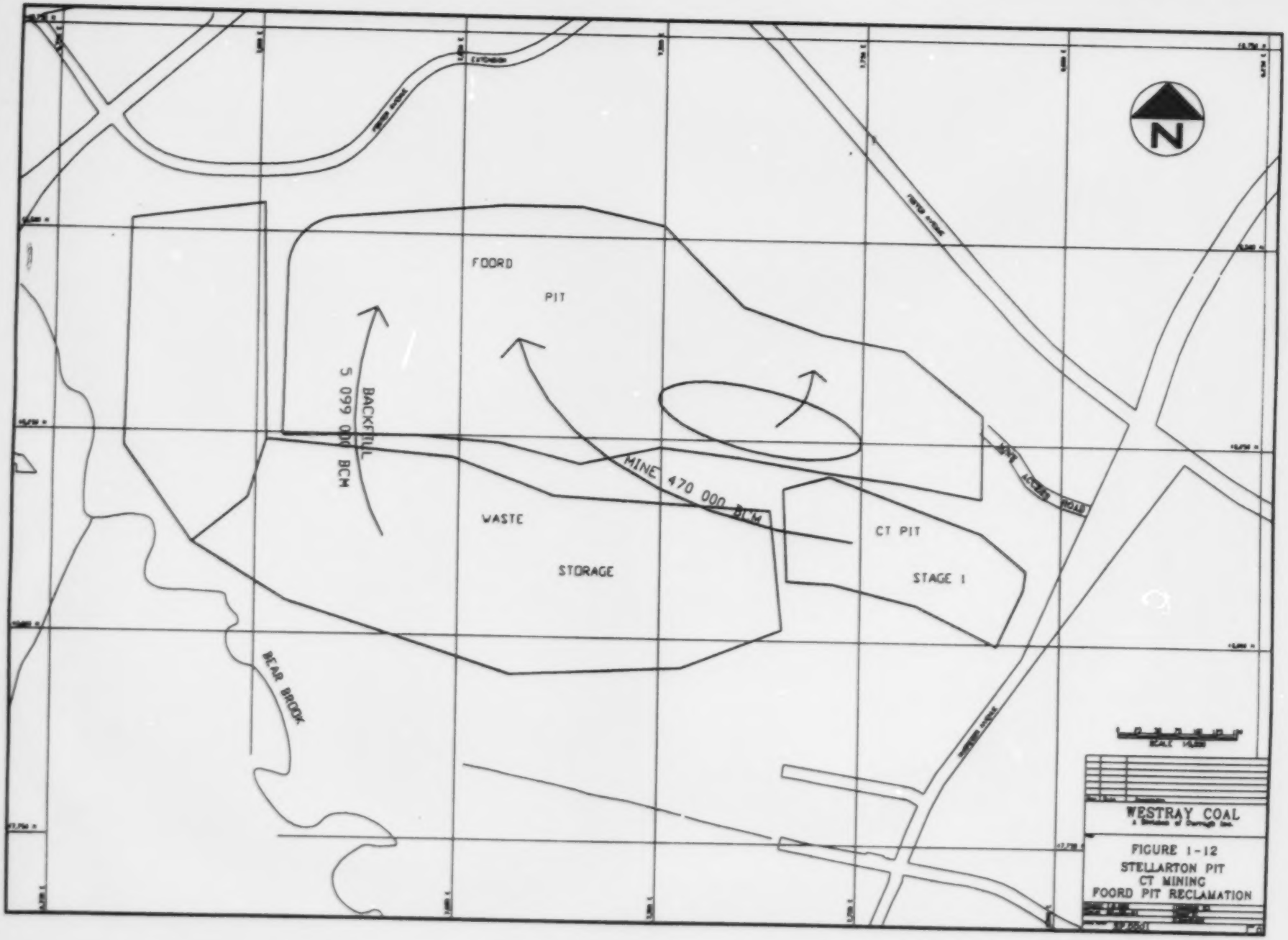
The reclamation plan for the mine site has been based on the assumption that the ultimate land use of the property will be one of recreational use (i.e. parkland).

Westray has developed its detailed reclamation plan as described in Section 1.3.2 on the assumption that all the waste material will be returned into the pits and the site uniformly graded with drainage directed to the two pond systems described in Section 1.4 (i.e. the South and West Ponds - See Figures 1-14, 1-15, and 1-16). There is, however considerable flexibility as to how the site could be finally contoured depending on what


N
MINE ACCESS ROAD
BEAR BROOK
WESTRAY COAL
FIGURE 1-9
STELLARTON PIT
CT MINING
STAGE 1 COMPLETE


N
BEAR BROOK
ACCESS ROAD
WESTRAY COAL
FIGURE 1-10
STELLARTON PIT
CT PIT
STAGE 2 COMPLETE


N
20
30
40
50
BEAR BROOK
WESTRAY COAL
FIGURE 1-11
STELLARTON PIT
CT PIT
STAGE 3 COMPLETE


N
FOORD
PIT
BACKFILL
5 099 000 BCM
MINE 470 000 BCM
WASTE
STORAGE
CT PIT
STAGE 1
BEAR BROOK
WESTRAY COAL
FIGURE 1-12
STELLARTON PIT
CT MINING
FOORD PIT RECLAMATION

N
WASTE
STORAGE
BACKFILL
470 000 BCM
CT
STAGE 3
BACKFILL
577 000 BCM
CT
STAGE 2
BACKFILL
498 000 BCM
CT
STAGE 1
MEAD BROOK
WESTRAY COAL
FIGURE 1-13
STELLARTON PIT
WASTE HANDLING
CT PIT STAGES 2 AND 3
MINING AND RECLAMATION

recreational use patterns the Town and local citizens would prefer to see for the site. Westray will therefore establish a reclamation planning committee involving all interested parties to obtain guidance on the preferred configuration of the land after it is reclaimed. This committee will include members of the existing Liaison Committee, Town officials, Provincial officials and Westray staff. It will be established early in the operation so that any preferred land configurations can be reflected in the operational plan of the mine at the earliest opportunity.

Although the lands are currently owned by the Crown, Westray is actively negotiating with the Province for the ownership of the land. Should Westray be able to accomplish this land ownership, then at the completion of reclamation, Westray will donate the land to the Town of Stellarton.

Westray is fully committed to complete reclamation of the disturbed areas. This commitment is backed by provisions of the Mineral Resources Act of the Statutes of Nova Scotia. Before mining can begin, security must be posted with the Department of Natural Resources to ensure that the reclamation will be carried out.

1.3.1 Provisions of the Mineral Resources Act

The relevant provisions of the Act are as follows:

Section 75

(1) The area disturbed by the former mining operations, including the area upon which waste rock and tailings were deposited, shall be reclaimed to the satisfaction of the Minister (of Natural Resources) by the lessee within twelve months of the cessation of production or such greater time as may be determined by the Minister.

(2) The cash or bond provided by the lessee is forfeited to the Department if reclamation has not been completed in accordance with subsection (1).

(3) Any unforfeited cash or bond provided by the lessee shall be retained until the area described in subsection (1) is inspected by an officer and the lessee is notified in writing by the Minister that the lessee is relieved from the obligation to maintain security for the purpose of reclamation.

Section 97

(1) The applicant for a mining permit or excavation permit shall post cash or a negotiable bond or other security in a form satisfactory to the Minister and in an amount determined in accordance with the regulations to provide for the reclamation of any area that may be disturbed by the activities of the permit holder or an agent or assignee of the permit holder.

(2) The security required pursuant to subsection (1) is forfeited to the Minister if:

a) in the case of a bond, it is not renewed at least thirty days before its expiry date and reclamation is not completed; or

b) reclamation has not been completed to the satisfaction of the Minister within the prescribed time.

(3) Subject to section 120, the security forfeited to the Minister pursuant to subsection (2) may be employed, in whole or in part, under the direction of the Minister to reclaim the area of mining activity and the balance of unexpended funds, if any, shall be returned to the payor.

Section 120

Where any debt, sum of money, royalty, rent, or tax is due and payable to the Crown by the lessee, the Minister may use and apply the balance of any money or security held, including the designated for the purposes of reclamation, if such reclamation has been completed to the Minister's satisfaction, to such debt, sum of money, royalty, rent or tax due and payable

to the Crown.

The Mineral Resources Regulations, made pursuant to the Mineral Resources Act, provides further requirements on reclamation bonds as follows:

Section 76

(1) Where a reclamation bond is required under the Act the security shall be posted with the Registrar.

(2) The amount of the security referred to in subsection (1) shall be calculated by the Director of Mines on a site specific basis and shall include the estimated aggregate cost for labour, equipment, supplies and services to conduct one or more of the following reclamation activities:

a) the removal of buildings and structures;
b) the removal or burying of foundations;
c) the capping or filling of pits, declines and shafts;
d) the stabilization of tailings disposal sites and drainage containment facilities;
e) surface contouring
f) establishing proper site drainage;
g) re-vegetation work; and
h) other work necessary to reclaim any area disturbed by the permit holder or an agent or assignee of the permit holder.

(3) The amount of the security determined pursuant to subsection (2) may be reviewed and adjusted by the Director of Mines every two years from the anniversary date of the reclamation bond.

(4) The time allowed for the completion of reclamation

a) shall be within eighteen months of cessation of production, or a longer period as may be determined by the Minister; or

b) pursuant to an excavation permit, shall be within thirty days of the completion of the work plan, or a longer period as may be determined by the minister.

1.3.2 Reclamation Plan

The reclamation plan for the Stellarton Pit site consists of the following activities:

a) returning excavated waste to the pits and recontouring the disturbed areas;
b) removing all structures, equipment and fences;
c) revegetating all disturbed areas; and
d) re-establishing proper site drainage.

The sediment control ponds will be maintained until the site is reclaimed and the new vegetation has been established. After that time, the sediment ponds will be reclaimed by back filling and revegetating. If deemed appropriate at the time, the ponds could be maintained in the area for recreational uses, however they would require modification to the slopes leading to the pond and to the depth of the ponds to ensure safety.

The reclamation plan hinges on the return of the waste material to the excavated pits. The mining plan has been laid out so as to, whenever possible, place waste directly into previously excavated areas, thereby making the reclamation a part of the mining process. Of the 8.9 million BCM (bank cubic metres) of waste material to be mined, approximately 3.3 million BCM will be placed into previously excavated areas. The remaining 5.6 million BCM of material will be placed in waste storage south and west of the

Foord pit. The material will be located as close to the pit perimeter as possible, in order to minimize the distance, and consequently the cost, of moving the material back into the pits.

The excavated pit volume will consist of the volume of coal and rock which was mined, but only the rock volume is available to be placed back in the pit, suggesting that there may be a depression left over after all the waste has been put back in the pit. This is not the case, however, as in excavating and replacing the waste, the material experiences an apparent increase in volume. This swell occurs as a result of the material being taken from a solid rock mass and then being replaced in a broken mass with an abundance of void spaces. Typically, these types of rocks will experience a "a swell factor", or apparent increase in volume, of 20 to 30 percent. This rock swell will in fact cause a slight increase in the overall height of the reclaimed topography from the original topography.

The following table (Table 1-2) demonstrates the effect of swell on the excavation and reclamation volumes for the range of swell factors.

TABLE 1-2

Reclamation Material Volumes

	CASE "A"	CASE "B"
Excavated Volume (BCM)	10,476,000	10,476,000
Waste Volume (BCM)	8,871,000	8,871,000
Swell Factor	1.2	1.3
"Swelled" Waste Volume (LCM)	10,645,000	11,532,000
Excess Volume (LCM)	169,000	1,056,000
Disturbed Area (square meters)	490,000	490,000
Increase in Elevation (metres)	0.3	2.2

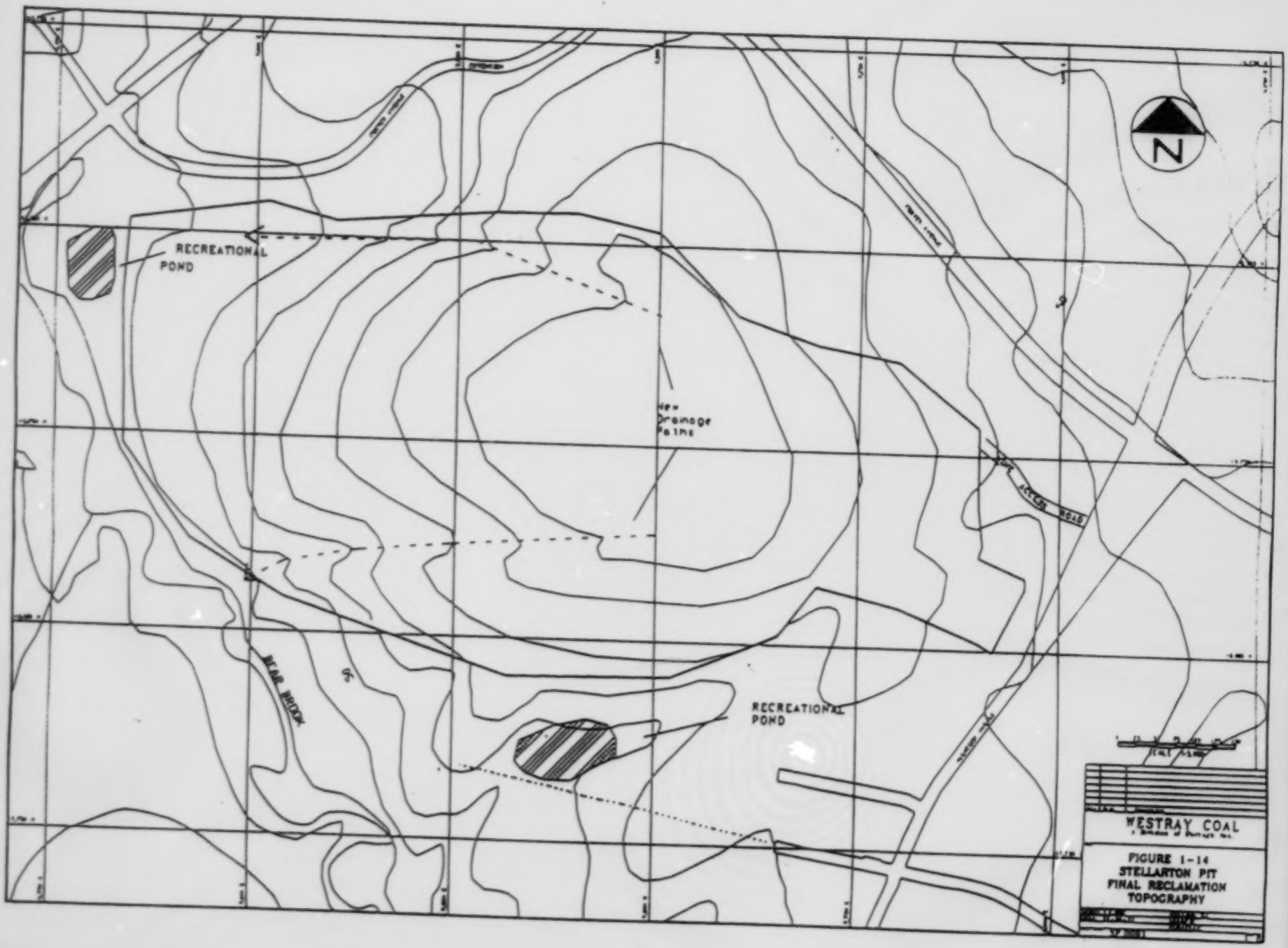
Figures 1-7, 1-8, 1-12 and 1-13 depict the waste movements over the life of the pits as well as during reclamation. The final contours of the site assuming a swell factor of 1.2 for the waste (case A, Table 1-2) will be as shown in Figure 1-14. The final reclamation potential for the site is presented in Figure 1-15.

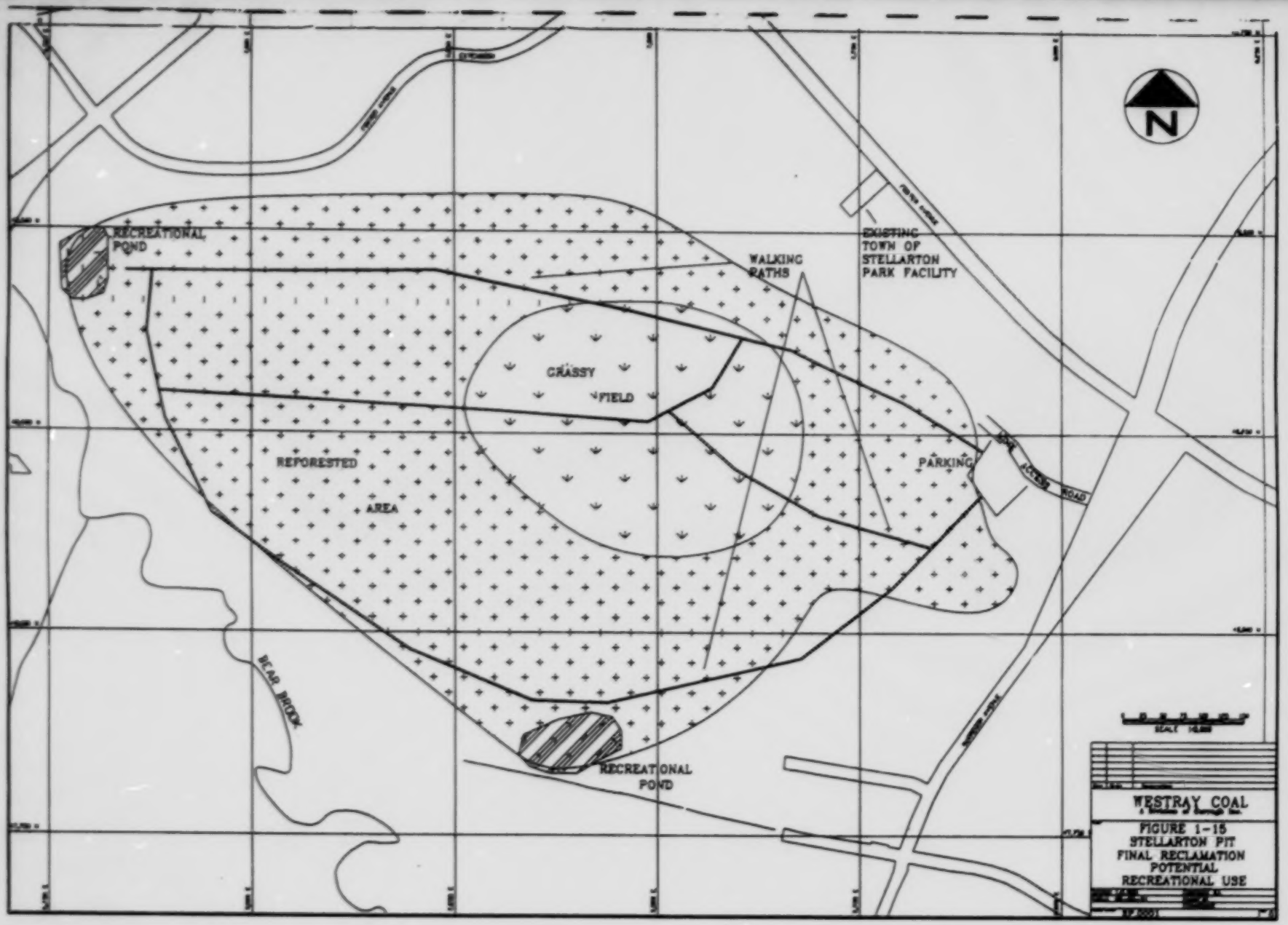
1.4 Surface Drainage

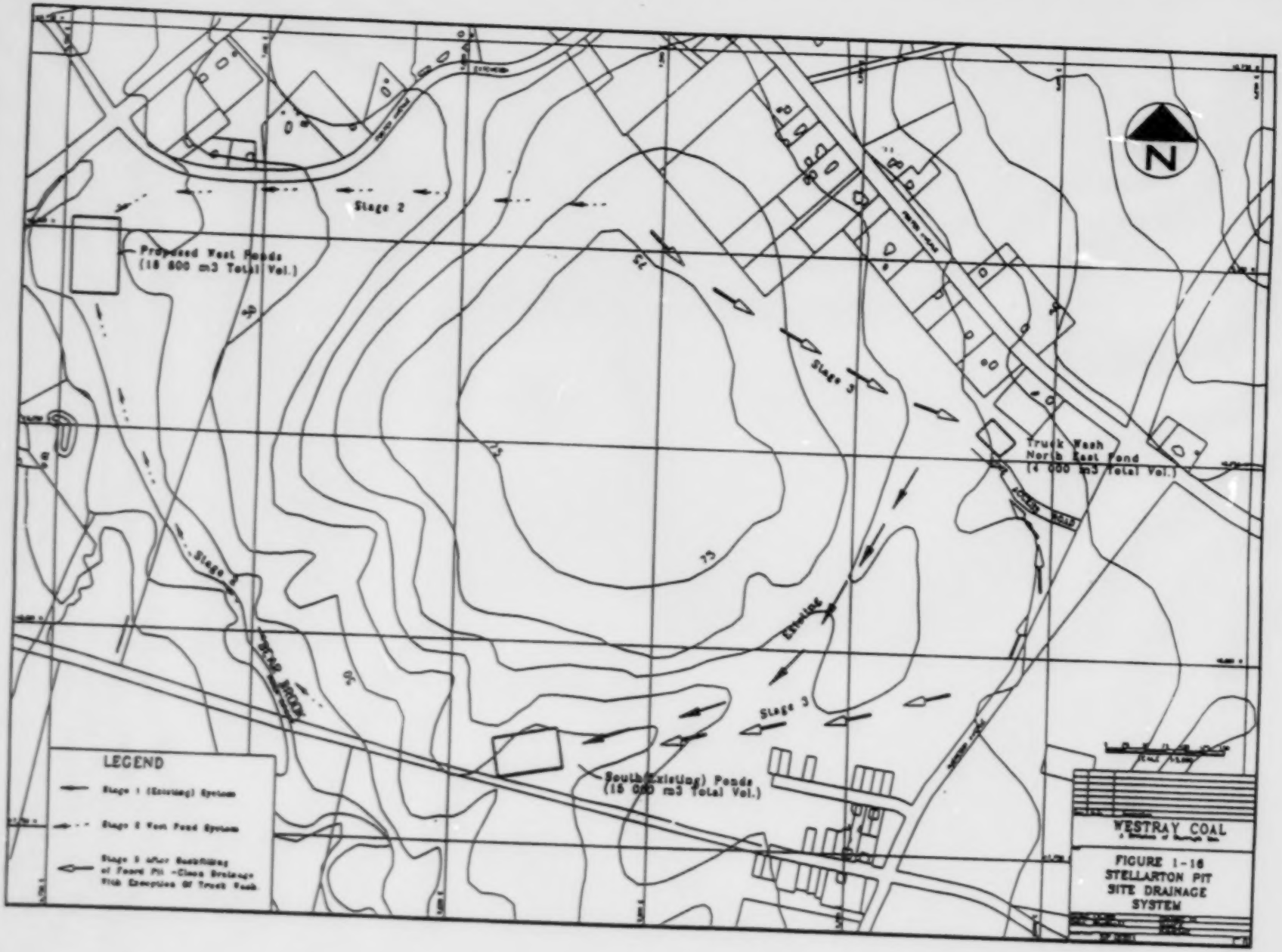
The site is situated on a local watershed divide although drainage patterns have been modified by the Bulk Sampling Program such that the entire area now drains into the Bear Brook watershed. Prior to this, the natural overland flow from the site generally occurred in two forms: in the eastern section of the site, where the topography generally slopes gently to the north and east, sheet flow runoff was predominant. Runoff from this section of the site eventually reached ditches along Foster Avenue and MacGregor Avenue and ultimately entered the East River system.

In the western section of the site, the slopes become rapidly steeper towards Bear Brook, reaching inclines of up to 12 degrees. Runoff generally occurred as gully flow in these areas and entered Bear Brook (Middle River Watershed) primarily via four short incised, first order unnamed tributaries. Excavation of the Bulk Sampling Pit and its associated ditching resulted in the drainage from virtually the whole site being controlled by this system. The system for the proposed new operation will incorporate and expand on this existing system. Thus, there will be a fully operational surface drainage control system in place prior to the initiation of the scheme.

As the mine develops, a three phase modification to the drainage system will be installed. The first phase will consist of the existing system which will be adequate for the Stage 1 Foord Pit development. However, at the start of operations, a new pond system will be constructed in the west corner of the site as shown in Figure 1-16. This constitutes Phase 2 and this will be used to control drainage from the west corner of the site including water pumped from the Foord Pit. Water from the truck wash will drain into the Foord Pit and so will be controlled by the system. The third phase will consist of a small third pond


N
RECREATIONAL POND
RECREATIONAL POND
WESTRAY COAL
FIGURE 1-14
STELLARTON PIT
FINAL RECLAMATION
TOPOGRAPHY


N
RECREATIONAL POND
WALKING PATHS
EXISTING TOWN OF STELLARTON PARK FACILITY
GRASSY FIELD
REFORESTED AREA
PARKING
ACCESS ROAD
BEAR BROOK
RECREATIONAL POND
WESTRAY COAL
FIGURE 1-15
STELLARTON PIT
FINAL RECLAMATION
POTENTIAL
RECREATIONAL USE


N
Stage 2
Proposed West Ponds
(18 800 m3 Total Vol.)
Stage 3
Truck Wash
North East Pond
(4 000 m3 Total Vol.)
Stage 2
Existing
Stage 3
South (Existing) Ponds
(15 000 m3 Total Vol.)
LEGEND
WESTRAY COAL
FIGURE 1-16
STELLARTON PIT
SITE DRAINAGE
SYSTEM

to be constructed in the NE corner of the site as the Foord Pit is backfilled. This will control water from the truck wash and other drainage from the NE corner of the site once it can no longer drain into the Foord Pit. The discharge from this pond, which will be quite small, will be to the local highway drainage system or into one of the other pond systems if required. The characteristics of the three phases of the drainage system are described in Table 1-3. Water balances are presented in Figure 1-17.

In our professional opinion, acid mine drainage is not expected to be an environmental concern at this site. Results of an analysis of rock core from a drillhole within the proposed site were submitted for acid generation potential testing. Results are presented in Table 1-4. There has been no evidence of any acid generation during the Bulk Sampling Program. Therefore, it is not anticipated that any special treatment measures will be required in this regard. However, in the unlikely event that acid drainage does occur, it can be treated with lime in the treatment ponds. Sludge removal and disposal system would have to be added to the system.

The system proposed will provide very adequate control of the entire site from the standpoint of sediment control. Performance of the treatment ponds to date is indicated in the discharge data shown in Table 1-5. The same method of batch treatment using flocculants will be maintained for the entire project.

The flocculant found to be best suited to treating the drainage during the Bulk Sampling Program were Klar-Aid 6433 and 6440 which are produced by Dearborn Chemical Co. Ltd. It is therefore anticipated that their use will be continued. Material Safety Data Sheets for these chemicals are included in Appendix 1.

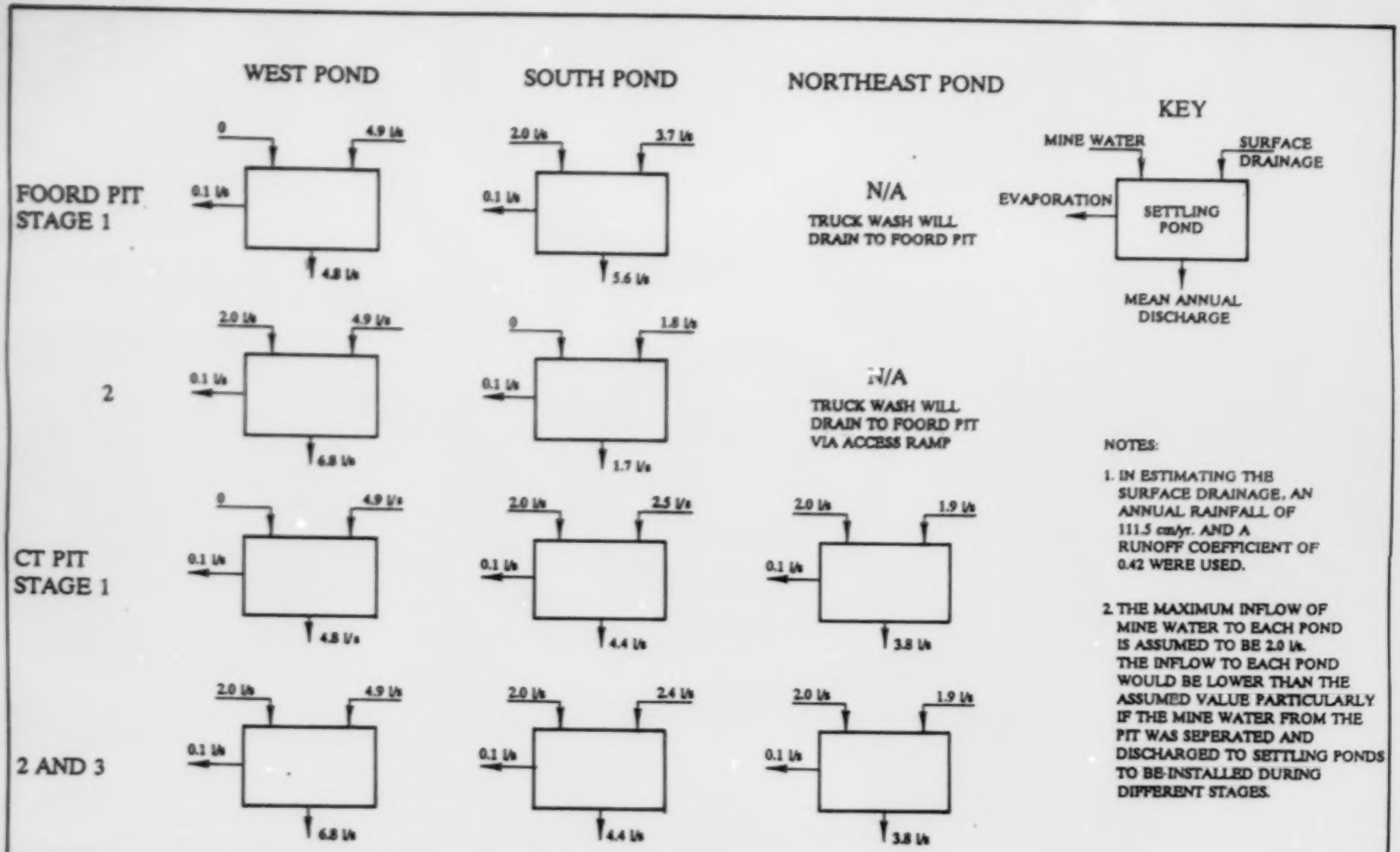
All ponds will be fitted with oil control booms.

TABLE 1-3
Summary of Calculated Pond Volumes

Description	West Pond				South (existing) Pond				NE Pond			
	Assumed Drainage Area (ha)	Assumed Disturbed Area (ha)	Cal. Vol. (m^3)		Assumed Drainage Area (ha)	Assumed Disturbed Area (ha)	Cal. Vol. (m^3)		Assumed Drainage Area (ha)	Assumed Disturbed Area (ha)	Cal. Vol. (m^3)	
			Crit. 1	Crit. 2			Crit. 1	Crit. 2			Crit. 1	Crit. 2
Foord Pit												
Stage 1	33	14	5600	4850	25	17	6800	3650	-	-	-	-
2	33	23	9200	4850	12	7	2800	1750	13	1	400	1900
CT Pit												
1	33	23	9200	4850	17	9	3600	2500	13	1	400	1900
2 and 3	33	11	4400	4850	17	6	2400	2500	13	1	400	1900
Proposed Pond Vol. (m^3)			9300				7500				2000	

Notes:

1. Proposed pond volume included the inflow of mine water at 2.0 l/s.
2. Criterion 1 means a requirement of 40 m^3 pond volume/1000 m^3 disturbed area by NSDOE
   Criterion 2 means a requirement to satisfy 10 h. retention of 24 hr for 1 in 10 yr. storm by Environment Canada.
3. Effluents from NE pond assumed to discharge to nearby drainage system (e.g. highway ditch) or pumped to Bear Brook at preference of regulatory agencies.
4. Ponds were built as two-pond systems with each pond having specified volume i.e. total is twice the proposed volume.



NOLAN, DAVIS & ASSOCIATES

FIGURE 1-17
CONCEPTUAL WATER BALANCES FOR TREATMENT PONDS

JUNE 1992

H92561

TABLE 1-4

Acid Generation Potential of Core Samples
Drillhole No. 8 (NSDME, 1974)
Stellarton Pit Mine

Sample	%S	pH	Theoretical Acid Production #/ton	Measured Acid Consumption #/ton	Net Theoretical Acid Consumption (-) or Production (+) +or - #/ton	Potentially Acid Generating
801	0.011	6.28	0.75	41.28	-40.53	No
802	0.017	6.62	1.04	43.86	-42.82	No
803	0.004	6.23	0.24	36.70	-36.46	No
804	0.017	6.45	1.04	38.11	-37.07	No
805	0.058	6.48	3.55	46.46	-42.91	No
806	0.140	6.39	8.56	48.81	-40.25	No
807	0.034	6.18	2.08	38.66	-36.58	No
808	0.007	7.12	0.43	33.73	-33.30	No
809	0.018	6.67	1.10	47.22	-46.12	No
810	0.039	5.96	2.38	52.22	-49.84	No
811	0.077	6.14	4.70	44.63	-39.93	No
812	0.037	6.32	2.29	39.06	-36.77	No
813	0.014	5.89	8.56	39.08	-30.52	No
814	0.066	6.44	4.03	36.58	-32.55	No
815	0.160	6.21	9.78	51.61	-41.83	No
816	0.011	6.24	0.75	30.32	-29.57	No
817	0.016	6.92	0.98	108.40	-107.42	No
818	0.120	6.53	7.34	33.19	-25.85	No
819	0.014	6.87	0.86	130.05	-129.19	No
820	0.180	7.08	11.00	61.92	-50.92	No
821	0.280	6.32	17.12	48.71	-31.59	No
822	0.081	6.73	4.95	33.69	-28.74	No

TABLE 1-5

Summary of Pond Discharge Data

Pond Discharge Event No.	Treatment Date (s)	Volume Discharged (m^3)	Flocculent Used	pH	Effluent Discharge Levels S.S.	Al	Fe	Oil
1	Feb. 28, 29 1992	1,555	6425	7.1	12	1.6	0.55	<1.0
2	March 9, 1992	2,320	6433	6.6	6			
3	March 11, 12 1992	6,730	6440	6.3	51	0.52	1.77	<1.0
4	March 15, 1992	5,685	6440	5.8	30	1.14	0.79	N/A
5	March 29, 30, 31 1992	6,683	6440	5.9	65	2.5	2.91	N/A
6	March 30, 31 1992	5,455	6433	6.3	22	1.3	N/A	<1.0
7	April 2, 1992	7,273	431/6433	6.1	35	0.7	1.19	<1.0
8	April 6, 1992	5,455	6425	6.5	21	0.65	1.31	N/A
9	April 25, 1992	1,228	6433	6.3	<5	0.08	0.03	<1.0
10	May 13, 1992	1,000	6433	6.9	11	0.38	0.64	<1.0

1.4.1 Erosion Control

The drainage control system described in the foregoing section will prevent the migration of any contaminated runoff from of the site before it has been adequately treated. It is inevitable in a site of this nature with active waste piles and earth moving activity, that there will be some erosion of these exposed surfaces leading to high sediment levels in the runoff before treatment. Westray will make every effort to reduce the area subject to erosion so as to reduce the loadings on the treatment ponds, to reduce the frequency at which the ponds might otherwise have to be cleaned and to control fugitive dust emissions from exposed surfaces.

Measures that will be applied include the following:

- Design and construction of waste dumps with benching to reduce erosion and gulleying of the slopes
- All areas contoured to their final grade will be fertilized and hydroseeded to promote rapid re-establishment of permanent vegetation
- Temporarily inactive areas subject to erosion will be stabilized with mulch, or geotextiles in extreme conditions
- Sediment traps will be constructed to slow erosional surface flows and reduce the volume of sediment reaching the main treatment ponds
- All channels for the drainage control system will be lined with rip rap.
- Routine inspections of the site and the drainage control system will be made with a view to constantly improving the erosion control measures and to check any maintenance requirements.

1.5 Pit Wall Stability

The slope angle of the pit walls is determined based on the stability of the rock mass. A preliminary slope angle of between 45 degrees and 65 degrees is judged to be a stable angle given the strength and structural characteristics of the rock. The final slope design will be approved by a professional engineer and submitted to the Department of

Natural Resources for approval, as required under the Mineral Resources Act.

1.6 Dump Stability

The design and construction of the waste dumps will also be reviewed by a professional engineer to ensure stability against slope failures. The waste dumps will, however, be susceptible to surface erosion as discussed, in Section 1.4.

1.7 Fire and Explosion Hazard

1.7.1 Methane

Methane gas, sometimes referred to as firedamp, always accompanies coal. It is formed at the same time as the coal is formed, from the same decaying vegetable matter. The gas escapes from the coal as it finds a pathway. Sometimes, the gas is slowly released over geologic time, especially when it is not confined by great rock pressures (i.e. when it is near surface). At other times, the gas does not find a natural escape, and is retained by the coal until released by man.

Methane is colourless, odourless, and tasteless. It has a density relative to air of 0.555. Consequently, when released to the atmosphere, it rises, and if contained, as can occur in abandoned underground workings, will tend to accumulate near the roof of the workings. Methane is a highly flammable gas when present in air at concentrations between 5 and 15 percent by volume. At less than 5 percent methane, a methane/air mixture will not continue burning due to a lack of fuel. At concentrations greater than 15 percent, the mixture is non-flammable due to a lack of oxygen. A concentration of 9.5 percent methane in air is generally considered to be the most dangerous.

Historical records of the Pictou Coalfield indicate that the coal seams are only moderately gassy on a global scale. Many seams throughout the world that are recognized as being very gassy or exceptionally gassy have a tendency towards sudden and sometimes violent discharges of large quantities of gas. These discharges are quite different from the gradual release of gas typical of the Pictou Coalfield.

In general, most of the methane present in coal is released during the actual mining operation. However, since not all the coal is removed during mining, it is inevitable that some methane emission into the abandoned workings will have occurred. Thus it is likely that the old workings, if not completely flooded or vented to the atmosphere, will contain some flammable gas, although the hazard from this gas, as described further, is not significant.

Although a flammable mixture of methane and air is dangerous if ignited, in most cases the resulting explosion is limited in both severity and extent. The principal danger is when the methane fire triggers a more violent coal dust explosion.

1.7.2 Coal Dust

Coal dust occurs as a byproduct of the mining and handling of coal. Mixtures of air and coal dust can be explosive. In order for the mixture to be explosive, it must be aloft and finely dispersed within the general body of air.

1.7.3 Spontaneous Combustion

Spontaneous combustion is the oxidation of any coal material where there is insufficient ventilating air to carry away the heat of oxidation, yet with sufficient air flow to maintain an oxygen supply. All coals absorb and combine with oxygen when exposed to air. This process releases heat, and the process forms carbon dioxide. If the ventilating air is not sufficient to carry away the heat generated by the reaction, the coal will become progressively warmer. The oxidation rate increases as the temperature increases, so the process accelerates until the coal eventually ignites; this ignition temperature typically varies from 250° C to 350° C. (Grierson, 1977).

The tendency towards spontaneous combustion varies both with the type of coal and the physical setting. While there are no analytical techniques available for predicting a tendency towards spontaneous combustion under given circumstances, there are some generally accepted observations on the phenomenon.

a) All coals combine with oxygen to a certain extent and self heating is due mainly to the chemical reaction with oxygen.

b) The presence of moisture in the coal has an accelerating effect on its oxidation. This effect is naturally negated if the water content is sufficient to block the oxygen flow (e.g. if the coal is submerged).

c) The higher the initial oxygen content of the coal, the greater the tendency towards spontaneous combustion.

d) The more fragmented or permeable the coal, the greater the surface area is in contact with the oxygen supply, and the risk of spontaneous combustion increases. (Fragmented coal may be found in abandoned workings as a result of pillar coal being crushed or from the degration of coal left in the roof.)

e) Bright coal bands are more subject to oxidation than dull coal bands.

Because Westray will only be mining near surface coal, the existence of crushed pillars is not expected.

1.7.4 Site Specific Hazards

The site specific hazards of the proposed project will vary with the conditions of the coal face. The coal face will either be solid (not previously mined), or will contain old workings.

When mining solid coal, methane gas being released from the newly exposed coal face will be quickly diluted by the open air. The methane, being lighter than air, will rise, eliminating the possibility of any explosive concentrations being formed. This is the typical situation in the Foord Pit, since for the bulk of the pit area, the coal seam here has not been previously mined. (Westray's bulk sampling activities did intersect several old shafts at the east end of the property, which are believed to be the western extent of the workings).

Mining in the CT Pit is anticipated to intersect old workings. These workings are remnants of room and pillar mining, in which only part of the seam was extracted. Typically, only 30 to 40 percent of the coal would have been extracted. In intersecting these openings, there are four possible conditions which could be found, namely the openings could be:

1) open and filled with an oxygen deficient atmosphere ("blackdamp");
2) open and flooded with water;
3) subsided to surface and vented to the atmosphere; or
4) substantially collapsed with water and/or gas filling the voids.

(Blackdamp refers to any atmosphere containing carbon dioxide and nitrogen in excess of the normal percentage, in which a flame will not burn due to a lack of oxygen. This atmosphere also will not support normal respiration. As previously stated, all coals oxidize to some degree, so any coal workings which are left unventilated for a substantial period will inevitably become oxygen deficient, as the oxygen is converted to carbon dioxide. The carbon dioxide is heavier than air, and thus settles down into the lower parts of the mine. This is a benefit as the carbon dioxide will smother the coal from any spontaneous heating.)

Gas Filled Open Workings

It is likely that the upper levels of the Cage and Third seams will be substantially open. If the workings above the water table are dry, they will be filled with carbon dioxide and perhaps methane gas. The presence of methane gas in this situation will have no effect on mine safety, as the atmosphere will not have sufficient oxygen to burn the methane. As the methane is vented to the open air by mining activities, it will quickly rise and dissipate in the atmosphere.

Flooded Old Workings

It is likely that the old workings will be flooded, however it is not known to what depth. Given the relatively shallow depth of mining proposed for the Cage and Third seams (20 metres) it is possible that the surface mining will be entirely above the water level in the old workings. While flooding is a perfect solution to any spontaneous combustion problem, the possibility exists that the process of spontaneous combustion will begin again if the old workings are drained. Should it be necessary to pump down the water from the old workings, this will be done just in advance of the coal mining, limiting the time available for spontaneous heating to take place.

Because of the extent of the workings, and the interconnection of the old mines, it is likely that the drawdown of water from one seam's abandoned workings will draw down the water in other workings. This could have the potential of introducing a fresh air flow through old workings, providing oxygen for spontaneous combustion. In order to guard against this hazard, Westray will adopt the following procedures when mining old workings:

1) All known openings at surface will be sealed with a clay plug. This will limit the flow of air through the workings.
2) When practical, samples of the mine atmosphere will be taken and analyzed for the presence of carbon dioxide and carbon monoxide, and oxygen deficiency, or other indications of heating.
3) The surface will be watched for any signs of smoke or steam being released from cracks near the workings.
4) If heating is detected, all sources of fresh air to the workings will be sealed off, and if this proves inadequate, water will be pumped back into the affected workings.

Collapsed Workings

The situation of collapsed workings is similar to the cases above. The significant difference is that if coal was left on the roof during mining (as would have been

common practice), the collapse would have caused breaking of the coal, resulting in increased surface area and an increased risk of spontaneous combustion.

Methane Risk

As the mining of the coal proceeds, methane will be liberated. In the solid (not previously mined) areas, this will not present a risk.

In the mining of the old workings, there is some possibility of methane being trapped and then liberated by the excavation. In this situation, the methane will quickly dissipate and be made harmless by dilution. In mining near old workings, Westray will adopt the practice of venting all abandoned workings, in order to allow the methane time to dissipate.

Coal Dust Hazards

The potential hazard due to coal dust can be assessed based on the current condition of the workings,i.e. flooded or not.

If the workings are currently flooded, the danger will only arise when the water level is lowered and the old workings are exposed to fresh air drawn into the mine. In this case, the dust will be wet and adhering to the roof, sides and floor of the workings. In this condition the dust is harmless, as the coal dust is not capable of exploding unless it is aloft in the atmosphere. If there is a long delay between drawing down the water and extracting the coal, the coal dust as it is dried out would probably cake and therefore would not become readily airborne.

If the workings are dry, they would be filled with an oxygen deficient atmosphere as previously described. This atmosphere would preclude any spontaneous heating and likewise any danger of explosion.

PART TWO

ENVIRONMENTAL SETTING

2.0 ENVIRONMENTAL SETTING

2.1 Introduction

This section of the report relies on a compilation of existing data complemented by site specific surveys in a number of important areas. Baseline environmental surveys were conducted for the area in 1977 in relation to the mining activity proposed at that time by George Wimpey Canada Limited. These reports dated July 1977 and September 1977 have been reviewed and incorporated where appropriate.

Site-specific investigations and monitoring undertaken for this report or for the associated Bulk Sampling Program include:

- total suspended particulates (dust);
- noise;
- surface water quality including suspended sediments;
- fish biology;
- terrestrial biology;
- groundwater and
- archaeology.

The results of these investigations are included in this section of the report.

General descriptive sections such as the Geological Setting have been included to provide the reader with a full perspective of the regional environmental setting.

2.2 Geological Setting

2.2.1 Physiography

The proposed mine site is situated on a topographic high near the junction of the of the Cumberland-Pictou Lowland and the Hants-Colchester Lowland. The Cobequid Mountains lie far to the west and the Pictou-Antigonish Highlands to the east. The extreme southeast corner of the Pictou Coal Field encroaches on the western edge of the Pictou-Antigonish Highlands. The mine location and physiographic regions are illustrated

in Figure 2-1.

Topographic elevations within the Lowland, range from sea level to 120 metres while more typically elevations range from 30 to 75 metres. Typically the topography consists of low undulating hills which reflect underlying bedrock structure or surficial deposits (Gibb and McMullin, 1980). Although the relief is generally undulating and smooth, areas with abundant exposed bedrock may exhibit a rough and jagged relief on a micro scale due to bedrock ridges (Suncor, 1983).

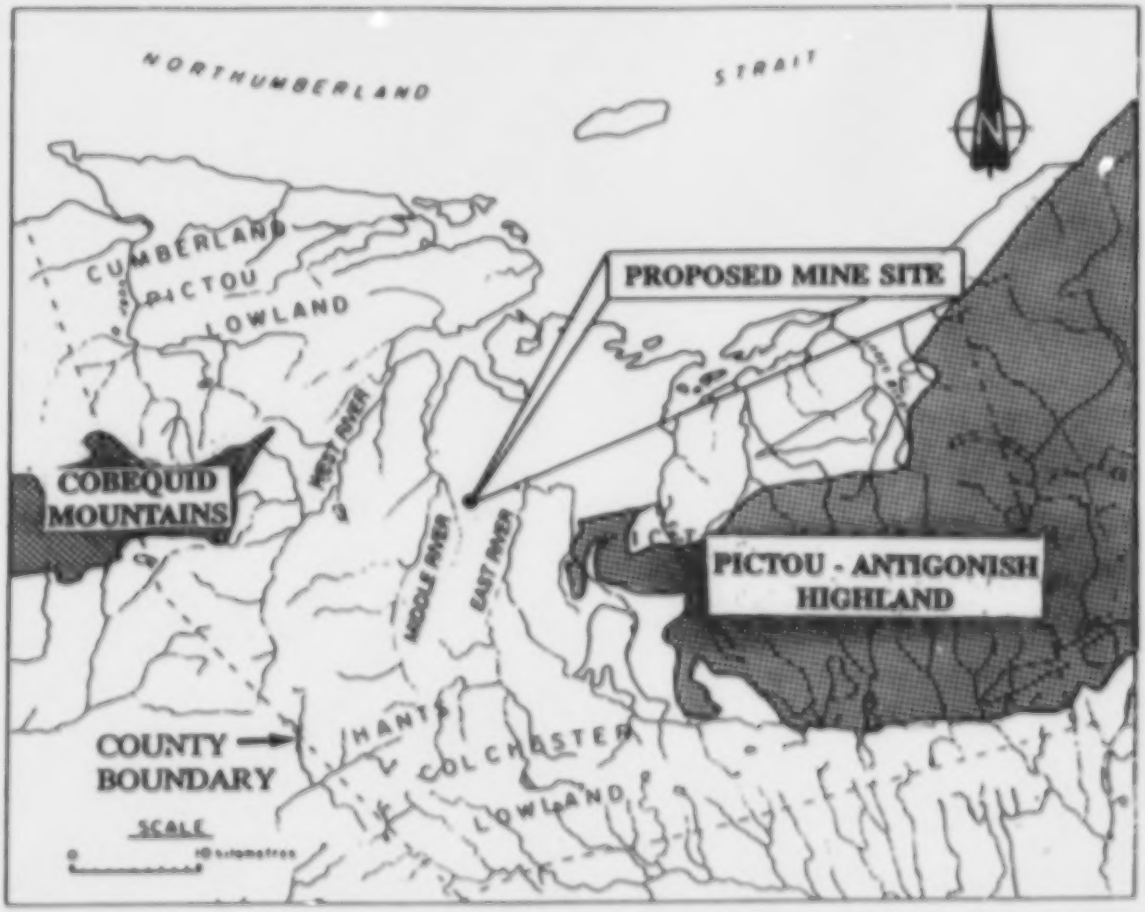
2.2.2 Surficial Geology

2.2.2.1 Pedology

The two most predominant soil types developed within the Pictou Basin are the Queens and Joggins Association soils (Cann and Wicklund, 1950). The Queens Association consists of light-brown loam to silty loam over light-brown clay loam. It is derived from a dark reddish-brown clay till which originated from reddish-brown shale. This soil type occurs between the Towns of Stellarton and Westville, south of these towns, and immediately east of Stellarton.

The Joggins Association soil consists of greyish-brown loam over mottled grey and yellowish-brown clay loam. It is derived from a grey-brown clay till and originated from a dark grey shale. The Joggins soil occupies most of the Pictou Basin area east and west of the East River. The Joggins Association soil occupies the northern section of the proposed mine site while the Queens Association soil can be found in the area of Bear Brook, south of the mine site.

Recent excavations associated with the Bulk Sampling Program at the site confirm existing mapping and indicate presence of the Joggins Association soil. This soil type is firm to compact and ranges from 0.1 to 0.45 metres in depth.



REFERENCE: REGIONAL WATER RESOURCES
PICTOU COUNTY, NOVA SCOTIA
DEPARTMENT OF THE ENVIRONMENT
HALIFAX 1980

NOLAN, DAVIS & ASSOCIATES

FIGURE 2-1
PHYSIOGRAPHIC REGIONS
OF PICTOU COUNTY

JUNE 1991

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2.2.2.2 Surficial Geology

Regionally, the surficial deposits within the area of the Pictou Coal Field unconformably overlie rocks of Carboniferous Age. These unconsolidated sediments are predominantly of glacial or glaciofluvial origin with minor alluvial deposits along the rivers and creeks. The overburden materials vary in thickness from a few centimetres to 30 metres; however, a thickness of 3 - 15 metres is more typical than the extremes (ibid.). Tills, which are the predominant overburden, vary from clay to gravelly tills depending on the parent material.

The Wisconsinan glaciation was the most recent ice sheet to cover the area, its retreat having occurred between 12,000 and 13,000 years ago. It seems likely that previous glaciations also spread ice over the area; however, the record of such events is not well understood or documented.

Excavations associated with overburden stripping to obtain the bulk sample at the proposed site indicate the presence of Eatonville Till. From site observations and previous work, (Stea and Myers, 1990) this basal till is characterized by its high percentage of silt and clay fractions (50-75 percent) with some sand & gravel and occasional cobbles and boulders. The Eatonville Till is typically classified as compact to very dense relative density and has a thickness varying between 3m and 13m at the site from drill hole information.

2.2.3 Bedrock Geology

2.2.3.1 Regional Stratigraphy

The regional stratigraphy of the area has been studied in detail by many workers and is well documented in the literature. Bell's (1940) work provides a readily available summary of the regional stratigraphy. The focus of the exploration, and of this discussion, is the coal measures of the Stellarton Group, and this is therefore described in greater detail.

2.2.3.2 Stellarton Group

Rocks of the Stellarton Group (also referred to as Stellarton Series), a sequence of shales, mudstones, sandstones, conglomerates, oil shales, and coals, form the coal-bearing measures in the Pictou Coal Field. The Stellarton Group is underlain either by the Canso Group, at an angular unconformity, or by the New Glasgow Formation at a disconformity. At the top of the unit is a lengthy unconformity extending from the Carboniferous rocks to the Quaternary glacial sediments.

Bell (1940) divided the Stellarton Group into six members for convenience of description and discussion. Some of the contacts adopted for use herein have been refined slightly from those proposed by Bell (1940); however, the basic concept and nomenclature have been retained.

Contacts have been chosen arbitrarily and are based on the practical principle of separating coal-bearing and non-coal-bearing sedimentary consequences. Members are not believed to be field mappable due to the relatively restricted outcrop in the coal field. They are, however, generally identifiable in drill holes providing sufficient markers are present to determine which part of the stratigraphic profile was cut by the drill hole.

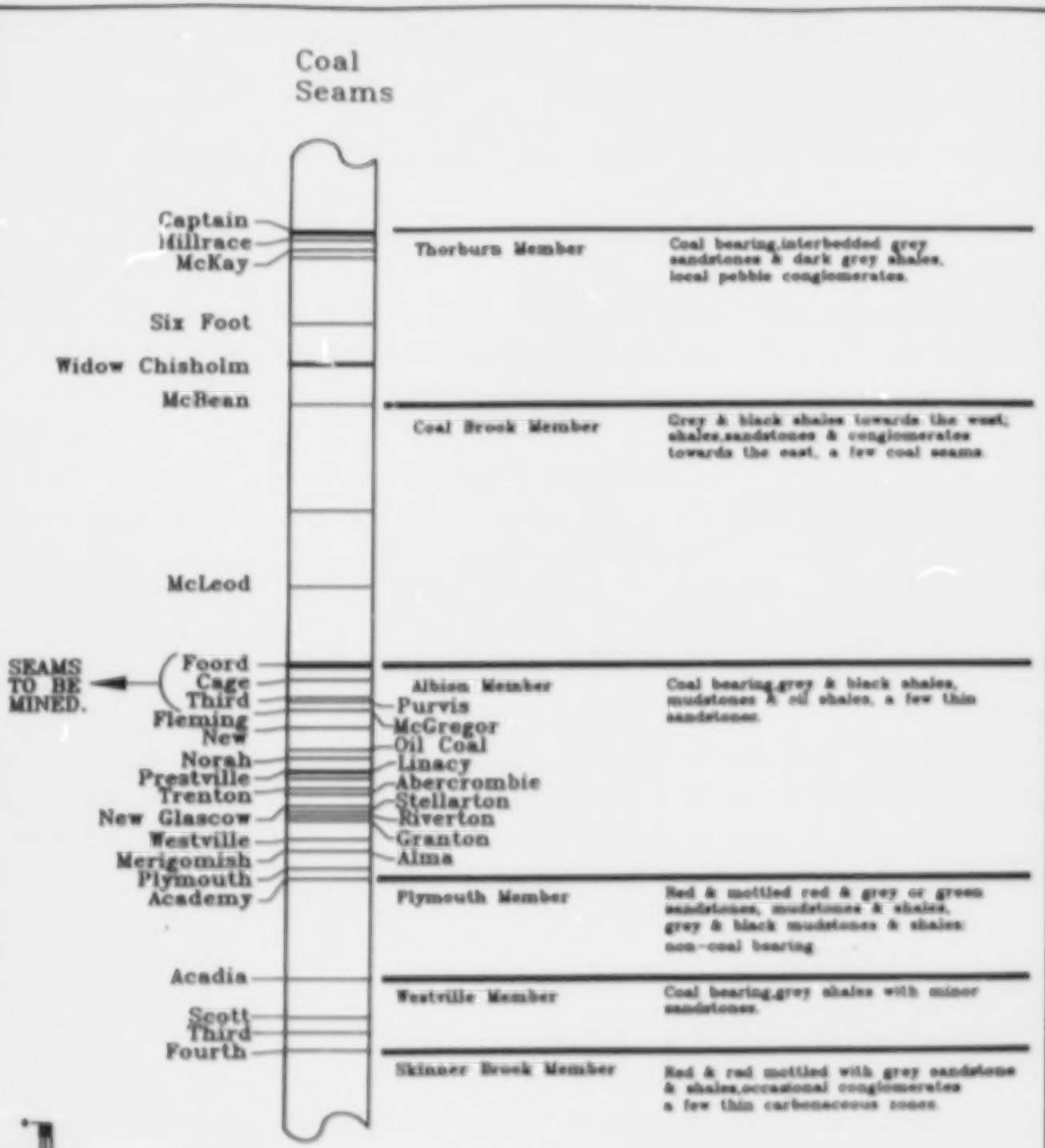
Figure 2-2 is a summary of the stratigraphy of the Stellarton Group, its members, and the coal seams in the sequence.

i) Skinner Brook Member

The sediments of the Skinner Brook Member form the basal unit of the Stellarton Group. The rocks lie in angular unconformity with Canso beds or at a disconformity with the conglomerate of the New Glasgow Formation (Cumberland Group). The upper contact has been designated as the base of the Fourth Seam of the overlying Westville Member.

ii) Westville Member

The Westville Member is the lowest of the coal-bearing sequences. Coal seams



NOLAN, DAVIS & ASSOCIATES

FIGURE 2-2
STRATIGRAPHIC SECTION OF THE STELLARTON GROUP

JUNE, 1993 1892561

included in the Westville Member are the Acadia, Scott, Third, and Fourth Seams. The Westville Member is defined as extending from the top of the Acadia Seam to the base of the Fourth Seam. Grey shales and sandstones occur between the coal seams.

iii) Plymouth Member

The Plymouth Member is the non-coal-bearing sequence extending from the top of the Acadia Seam to the base of the Academy Seam of the overlying Albion Member. The rocks of this unit are black, grey, green, red, and mottled green and red shales and mudstones with lesser amounts of sandstone and occasionally conglomerates.

iv) Albion Member

The Albion Member is the most prolific of the coal-bearing sequences in the sedimentary basin with more than twenty coal seams of varying thickness recorded. The Albion Member extends from the base of the Academy Seam to the top of the Foord Seam. The mining block of the proposed surface mine operation constitutes part of the Albion Member. A total of seven coal seams are in the proposed mining block, namely; the Foord, Case, Third, Purvis, Fleming, MacGregor and New Seams, but only the Foord, Cage and Third seams will be mined.

v) Coal Brook Member

The Coal Brook Member overlies the Albion and contains only a few coal seams, most notably the McLeod Seam which is up to two metres thick, discontinuous (and/or tranaitional into oil shale), and occurs approximately 150 metres above the Foord Seam. As well, several very thin coals occur approximately 80 metres below the McBean Seam and another thin, discontinuous seam occurs approximately 300 metres above the Foord Seam.

vi) Thorburn Member

The Thorburn Member is the upper member of the Stellarton Group. Bell (1940) has estimated that the unit is approximately 500 metres thick. It consists of interstratified grey conglomerates, sandstones and shales, and coal seams. The lower contact is defined

as the base of the McBean Seam and the upper contact the unconformity marking the top of the Stellarton Group.

2.2.3.3 Bedrock of Proposed Site

The bedrock which underlies the proposed surface mine operation consists predominantly of shale and mudstone interbedded with sandstone, coal and conglomerate belonging to the Albion Member of the Stellarton Group.

These lithologies range in colour from buff to grey-black and are characteristically friable. These sedimentary rocks have been gently folded and dip moderately, approximately 25 degrees, to the north and strike in a general east-west direction.

2.3 Atmospheric Environment

2.3.1 Climate

The mine site is located within a cool, humid, temperate climatic zone. This zone is influenced by prevailing westerly winds which cause many of the low-pressure systems moving across North America to pass over Atlantic Canada. The frequent passage of these systems, plus its maritime location, result in abundant precipitation within the study area (approximately 1100 mm/year).

The study area experiences a modified continental climate, exhibiting variability in all seasons. This results from the interaction of continental and maritime air masses, and because most of the weather systems originate in the interior, continental influences often dominate the marine influence. The continental influence in the area produces a wide range in annual temperatures. Winters are typically cold with frequent snowfalls; springs are late, cold and cloudy; summers warm and relatively humid. In general, rainfall is most abundant during the fall months. The prevailing winds are westerly and northwesterly in the winter months and south to southwesterly during the summer months.

Oceanic influences tend to moderate the climate, thereby reducing the temperature range in coastal areas; resulting in milder winters, cooler summers, and longer frost-free periods than in the interior. The Northumberland Shore area is an exception, because the waters of the Northumberland Strait are typically warmer, tending to keep air temperatures warmer in summer and into the fall. However, in winter, the ice covered strait has little influence in moderating air temperatures and also delays spring warming.

2.3.2 Meteorology

2.3.2.1 Temperature and Precipitation

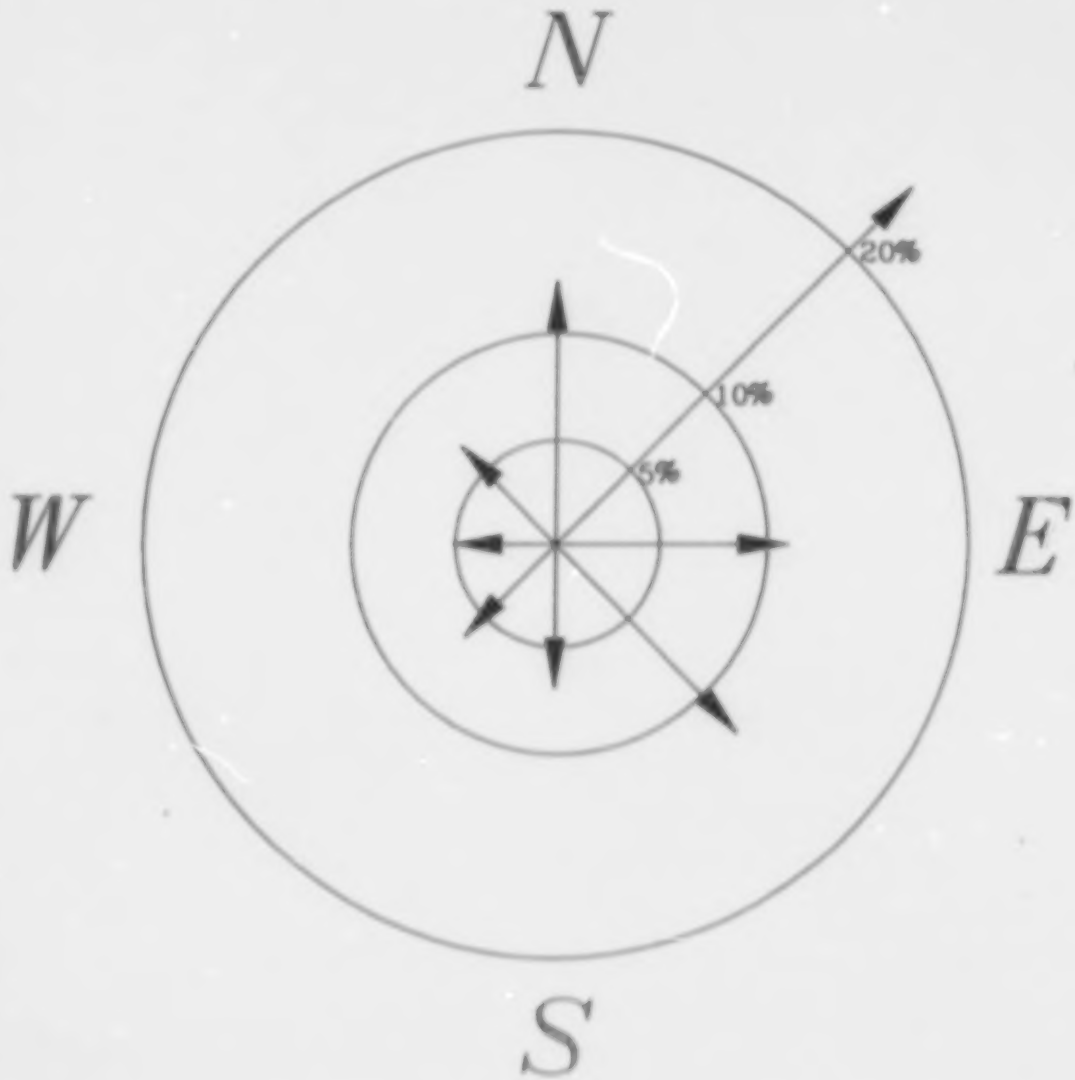
Basic meteorological data were obtained from the Atmospheric Environment Service of Environment Canada.

The Northumberland Shore/Cumberland Basin climatic region is characterized by cool summers, mild winters, coastal fog (particularly in spring and fall), and moderate precipitation. Coastal fogs on the Northumberland Strait are generally less frequent, and total annual precipitation is lower than along the Fundy and Atlantic coasts. Coastal areas are affected by westerly and northwesterly winds in winter and generally experience stronger winds than points inland. Northwesterlies in the spring are frequently responsible for cooler temperatures and delayed plant growth along the Northumberland Shore, compared to more inland areas.

Average annual precipitation at Stellarton is 1060 mm, 860 mm of which is in rain and 200 mm as snow. Further inland and at a higher elevation, at Hopewell, total precipitation averages 1220 mm of which rain and snow are 953 mm and 267 mm respectively. A climatology summary based on 1951 to 1980 data is given in Table 2-1.

2.3.2.2 Winds

Figure 2-3 presents the wind rose for the nearest wind observation station, at Abercrombie Point. Wind speed data is provided in Table 2-2. Predominant winds are from the south to west compass quadrant representing 57 percent of wind direction during the



NOLAN, DAVIS & ASSOCIATES

FIGURE 2-3
WIND ROSE FOR
WESTRAY AREA
(ABERCROMBIE POINT)

JUNE, 1992

RR0541

year. North and easterly winds tend to predominate during storm events while winter winds are often from the north and west quadrant. East and south-east winds are lowest in occurrence.

TABLE 2-1

Climatology Summary

Station Elevation (m)	Hopewell (152)	Stellarton (11)
Temperature (C)		
- annual mean	n/a	6.3
- maximum mean daily	n/a	24.5 (Jul.)
- minimum mean daily	n/a	-11.3 (Feb.)
- extreme maximum	n/a	35.0 (Aug.)
- extreme minimum	n/a	-39.4 (Feb.)
Precipitation (mm)		
- annual total	1219.5	1060.5
- rainfall	953.3	859.8
- snowfall (cm)	266.0	200.9
- maximum mean monthly	137.7 (Nov.)	123.6 (Nov.)
- minimum mean monthly	79.9 (Apr.)	70.3 (Jun.)
- greatest rainfall in 24 hrs.	193.8 (Aug.)	165.5 (Aug.)
- greatest snowfall (cm) in 24 hrs.	36.0 (Feb.)	40.6 (Mar.)
- days with rain	125.0	120.0
- days with snow	49.0	43.0
- days with precipitation	166.0	155.0

Average annual winds at Abercrombie Point are 17.7 kilometres per hour (km/hr) which is on the high side of regional averages which are determined primarily by adjacent geography. Winds are strongest during winter months and peak in December at 20 km/hr average. Maximum hourly speeds range from 50 km/hr in August to 74 km/hr from January to April inclusive.

Wind speeds at the mine site will be slightly lower due to its inland location but will retain the same directivity.

TABLE 2-2

Wind Speed Data
Pictou County

Month	Mean[1]	Maximum & Direction
January	18.6	74 S
February	18.6	74 SW
March	20.4	74 NW
April	18.3	74 NW
May	18.9	60 NW
June	16.1	50 SW
July	15.9	58 S
August	14.6	50 NW
September	15.6	64 N
October	17.5	58 SW
November	18.3	60 W
December	20.0	68 NW
For Year	17.7	74 SW

[1] Mean - Mean Wind Speed, km. per hour
Maximum - Maximum hourly speed, km.

2.3.3 Air Quality

The existing air quality in the region is influenced by natural conditions, local point sources, distant point sources and mobile sources. Larger, local point sources of emissions include producers of aggregates, asphalt, chemicals, coatings, electrical power, pulp, railway rolling stock, tires and wood products.

Other local air quality influences include traffic related emissions or intermittent agricultural/industrial operation or equipment sources.

More distant air quality influences include contributions from the industrial complexes in the Sydney and Halifax area as well as from Central Canada and the New England states.

2.3.3.1 Regional Air Monitoring

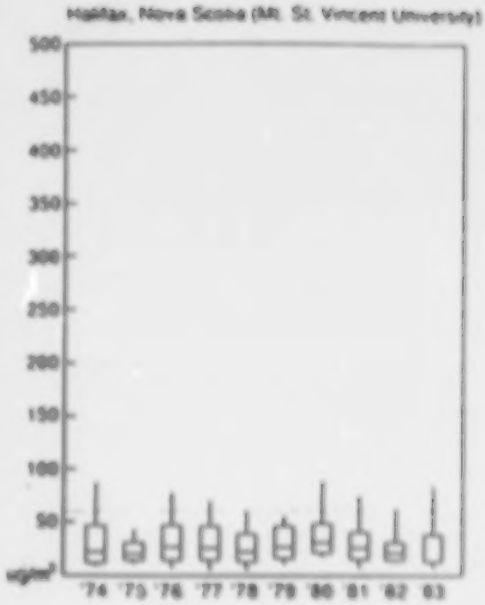
The National Air Pollution Surveillance (NAPS) network has been established to monitor air pollution levels in Canada. There are five sites in metro Halifax, two in Sydney, N.S. and one each in Saint John, N.B., St. John's, Nfld., Charlottetown, P.E.I., Glace Bay, N.S. and Fredericton, N.B. Not all pollutants are measured at each site. Data from the Atlantic province stations, local monitoring facilities and from elsewhere on the continent are used to present information of the existing air quality in the study area.

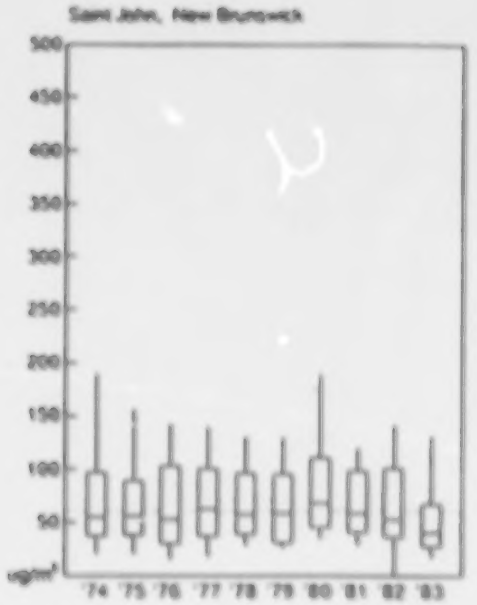
2.3.3.2 Total Suspended Particulates

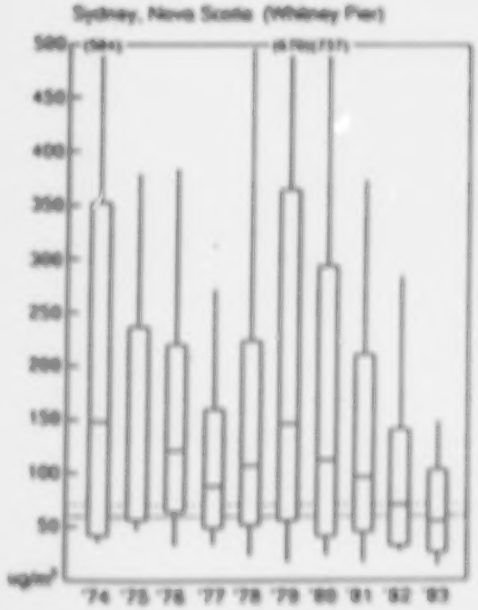
Total suspended particulates (TSP) is the most relevant parameter relative to the proposed mine site. It describes solid or liquid particles which tend to stay suspended in the air and can be easily respired into the lungs. Particulates are the most commonly observed form of air pollution, resulting in visibility reduction, soiling, and respiratory irritation. Point sources for TSP in Nova Scotia include thermal generation plants, pulp and paper mills and other industrial operations. Environment Canada has estimated that out of 780,000 tonnes of TSP emissions generated in Nova Scotia in 1980, 55 percent was from unpaved roads, 35 percent resulted from construction sites and 3.5 percent was dust from paved roads. Wood fuel burning, slash burning, quarrying operations, agriculture and asphalt production resulted in an estimated 1.0, 0.8, 0.5, 0.7 and 0.4 percent respectively.

Background TSP levels in North America generally average less than the 60 microgram per cubic metre ($\mu g/m^3$) "Maximum desirable objective" and the 120 ($\mu g/m^3$) "Acceptable limit" for a 24 hour period as set by regulatory authorities. Figure 2-4, reproduced from Eaton et. al., provides suspended particulate matter data for several locations in Nova Scotia as well as information on Canadian and U.S. means. Results in metro Halifax were similar in 1989 with the Technical University of Nova Scotia site

SUSPENDED PARTICULATE MATTER







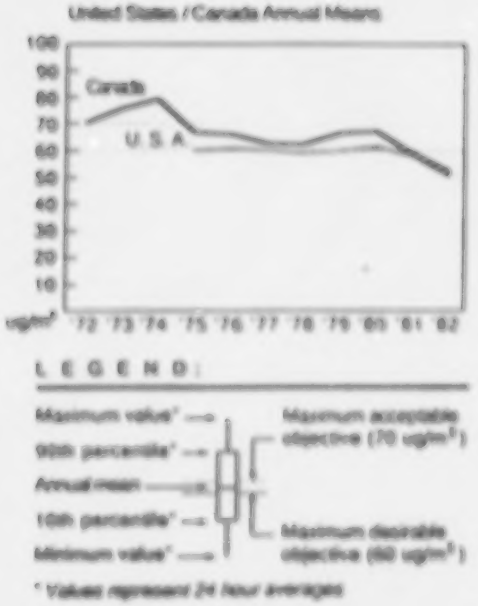


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FIGURE 2-4
AMBIENT AIR MONITORING TRENDS FOR TOTAL SUSPENDED PARTICULATES(TSP) IN ATLANTIC REGION CITIES (1974-1983)

JUNE 1985 [illegible]

registering an annual geometric mean of 22 $\mu g/m^3$.

Localized readings adjacent to industrial facilities and roadways can be significantly higher. Sampling was conducted for four days in June, 1991 at Alma and Greenhill, Nova Scotia and found a range in TSP from 13.2 to 95.6 ($\mu g/m^3$), with the higher concentrations attributed to greater traffic on weekdays during a particularly dry season. Levels monitored in Pictou during 1991 showed an average of 32 ($\mu g/m^3$) over a seven month period.

Dust monitors have been operational at four locations close to the proposed mine site since January 1992. Locations are shown in Figure 2-5 and the data are presented in Table 2-3. It should be noted that levels specified by the NSDOE were exceeded on several incidences prior to and subsequent to the period of mining, indicating that natural or other influences sometimes cause elevated levels in the area. The data collected by Wimpey in 1977 is comparable to the more recent assessment.

2.3.3.3 Polycyclic Aromatic Hydrocarbons (PAH's)

PAH's cause concern because of their indicated ability to precipitate changes in living cells. PAH's are created by smelting operations and motor vehicles and are generated in large quantities by wood combustion. PAH levels in Truro and Lower Sackville, N.S. were found, in a 1985 study, to range between 0.1 and 30 nanograms per cubic metre (ng/m^3). These levels were interpreted as being well below those which would have a public health impact. Ambient levels in the study area would be expected to fall in the lower middle to upper portion of the range depending on the season of the year.

2.3.3.4 Sulphur Dioxide

Sulphur dioxide originates from several regional sources. However, 75 to 80 percent of the sulphur deposited in the region originates in Central Canada and the northeastern U.S. Power generation produces 87 percent of the region's own sulphur dioxide production while fuel combustion, including motor vehicle operation, produces 90

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FIGURE 2-5
NOISE AND DUST MONITORING STATIONS
WESTRAY STELLARTON PIT MINE

JUNE, 1991

TABLE 2-3
Total Suspended Particulate (Dust) Monitoring
Stollarton Pit Mine
1992

Date	STATION				
	D1	D2	D3	D4	D4A
Jan.30/31	-	-	125.4	-	
Jan.25/26	-	-	17.9	-	-
Jan.31/Feb.1	10.8	61.7	9.7	-	-
Feb.6/7	22.7	21.8	18.0	12.7	-
Feb.9/10	25.2	n/a	35.6	85.1	-
Feb.12/13	14.3	22.5	12.4	10.1	-
Feb.15/16	71.5	87.7	90.7	n/a	-
Feb.18/19	36.3	25.5	24.2	n/a	-
Feb.21/22	17.1	18.9	19.3	14.7	-
Mar.1/2	0.17	1.5	1.1	8.8	-
Mar.4	19.3	8.0	14.2	2.0	-
Mar.6/7	26.5	33.2	72.0	33.3	-
Mar.9/10	31.0	24.8	24.3	21.5	-
Mar. 11/12	74.7	72.8	45.6	36.2	-
Mar.13	92.4	53.7	1.4	-	39.4
Mar.16	n/a	2.1	24.3	-	28.0
Mar.18	74.0	61.0	157.8	-	77.5
Mar.20	29.3	28.0	189.6	-	29.8
Mar.23	2.6	4.2	32.5	-	16.1
Mar.25	80.4	75.6	100.7	-	80.0
Mar.27	92.8	67.7	68.8	-	66.3
Mar.30	111.8	107.2	76.9	-	77.0
Apr.1	37.6	100.9	50.3	-	36.2
Apr.3	41.4	46.6	57.2	-	51.2
Apr.6	13.2	9.2	20.3	-	23.3
Apr.8	84.7	21.2	16.0	-	81.6
Apr.10	19.8	n/a	14.5	-	22.0
Apr.13	10.3	21.1	14.5	-	7.4
Apr.15	66.0	47.6	59.0	-	33.7
Apr.17	57.3	n/a	64.8	-	50.0
Apr.20/21	163.0	n/a	113.8	-	280.1
Apr.22	55.4	66.8	77.2	-	73.8
Apr.24	72.6	51.3	50.2	-	68.0
Apr.27	12.9	19.3	18.5	-	17.5
Apr.29	135.5	91.1	61.8	-	20.3

Note:

- Dust monitor not in service

On March 13/92 D4 moved to D4A

Concentrations micrograms per cubic metre (µg/m³)

N/A: Not available

Daily Average Compliance Limit: 130 (µg/m³)

percent of the remaining 13 percent. "Maximum acceptable" annual means have been set at 20 parts per billion (ppb) while "Maximum desirable" limits are 10 ppb. Between 1974 and 1983, readings at Mt. St. Vincent University in Halifax ranged up to 0.5 ppb, averaging less than 0.1 ppb. In 1989, sulphur dioxide levels in Sydney, Nova Scotia averaged 2 ppb, while in Charlottetown and Saint John, yearly averages of 2 and 7 ppb were recorded. Annual means for the study area are likely to be in the 4 to 6 ppb range.

2.3.3.5 *Nitrogen Dioxide*

Gasoline combustion is the largest single source of nitrogen dioxide generation in the Atlantic region, followed by diesel engines, industrial fuel and power plant combustion, fuel wood burning and residential and commercial fuel combustion. Point sources include thermal plants, oil refineries and pulp mills. In 1980, Nova Scotia produced an estimated 48,000 tonnes of nitrogen dioxide emissions. Oxides of nitrogen can be carried thousands of kilometres from the point of emission.

The "Annual maximum acceptable" limit for nitrogen dioxide is 50 ppb while the "Maximum desirable" limit is 30 ppb. Readings at Shearwater ranged up to 90 ppb between 1974 and 1983, averaging well below 10 ppb. Readings in downtown Halifax averaged up to 40 ppb during the early 1980's but annual means are generally less than 30 ppb. Annual means for stations in Canada and the U.S.A. were around 25 ppb during the same period, slowly dropping over the years. Annual averages in the study area would be expected in the 12 to 25 ppb range.

TABLE 2-4

Suspended Particulate Sampling Data Statistics (micrograms per cubic metre)

Location	Parameter	Month						Mean
		Jan.	Feb.	Mar.	Apr.	May.	June	
D1	Average	10.8	31.2	52.9	59.3	61.22	70.67	47.7
	Range	10.8	14-71	0.2-111	10-135	13.9-87.5	8.9-137.3	
	No./Tests	1	6	12	13	9	13	54
D2	Average	61.7	35.3	41.5	47.5	64.07	73.27	53.9
	Range	61.7	21-87	1-107	9-100	29.5-103	16.1-143.3	
	No./Tests	1	5	13	10	9	13	51
D3	Average	51.0	33.4	62.2	48.2	85.03	89.72	61.6
	Range	9-125	12-90	1-189	14-113	32.7-136.4	23.4-146.6	
	No./Tests	3	6	13	13	9	13	57
D4	Average	N/A[1]	30.6	20.4	N/A	N/A	N/A	25.5
	Range		10-85	2-36				
	No./Tests		4	5				9
D4A[2]	Average			51.9	59.5	58.5	62.95	58.2
	Range			16-80	7-288	34.1-114.8	24.6-106.6	
	No./Tests			8	13	9	12	42
	Overall							53.3
	Range							2-288
	No./tests							213

1 Sampler not in operation.

2 On March 13/92, monitor D4 was moved from near CN right-of-way at south west corner of site to a site on Foster Avenue.

3 Overall average for "down-wind" locations. (D1, D2, D4)

2.3.3.6 Carbon Monoxide

In 1980, 77 percent of the carbon monoxide produced in Nova Scotia was estimated to have come from gasoline powered vehicles. Other sources include slash and fuel wood burning, non-highway and off-highway gasoline use and diesel combustion. Point sources include oil refineries, thermal plants and pulp mills. Annual means for carbon monoxide declined during 1974 to 1978 but have remained more constant since. Target levels are expressed in terms of short term exposures with the "Maximum desirable" 8 hours limit being 5 ppm. Test results in downtown Halifax ranged up to 9 ppm between 1977 and 1983, averaging less than 2 ppm. The annual mean for downtown Halifax in 1989 was 1.0 ppm, while in Toronto it was as high as 2.4 ppm. Canadian annual means for urban centres averaged about 1.6 ppm between 1977 and 1981. Annual mean for the study area would be less than 0.8 ppm.

2.3.4 Sound Levels

Sound is a sensation produced in hearing receptors as the result of waves or vibrations caused in the surrounding air by a disturbance. Sound levels decrease with distance and are also attenuated by geographic and surface features. Different vibration frequencies create different pitches of sound. Noise is defined as unwanted sound.

The minute variations in air pressure which result in sound are measured by sound level meters which are calibrated to describe those levels in decibels (dB). Weighting networks are built into meters to result in different responses to portions of the sound frequency spectrum received. The "A" weighting network most closely corresponds to the range of human hearing and is therefore used in most sound impact assessment work with measurements recorded in units of dBA.

Figure 2-6 relates various dBA noise levels to common hearing experiences. Extremely low levels of sound are in the 20 to 35 dBA range while sounds causing immediate and noticeable disturbance start at 70 to 80 dBA. A quiet location such as a library or inactive residential area will register a sound level of approximately 35 dBA. A tractor trailer passing by at a distance of 15 metres will create a 90 dBA reading, similar to that of a blender at one metre.

Several different sound level parameters can be used to characterize a situation. Intermittent sound is described in terms of peak or maximum dBA level. For impact assessments, average levels have proven useful in gauging reaction to existing and changing sound levels. L_{eq} is such an average. It is a descriptor which averages the noise energy received over a time period and describes it as the average noise level which would have to exist over the same period of time in order to produce the same total acoustic energy at the receiver.

The current permit for the coal sampling operation allows sixty second L_{eq} sound levels of 65 dBA. Fourteen monitoring stations have been established in the mine area since January 1992 with readings taken on a tri-weekly basis. The locations of these stations are shown in Figure 2-5. The data collected is summarized in Table 2-5. The average Leq monitored over the period is 52 dBA with a range of 28 dBA to 71 dBA. The data collected by Wimpey in 1977 involved 10 stations and shows background noise levels comparable to the more recent data.

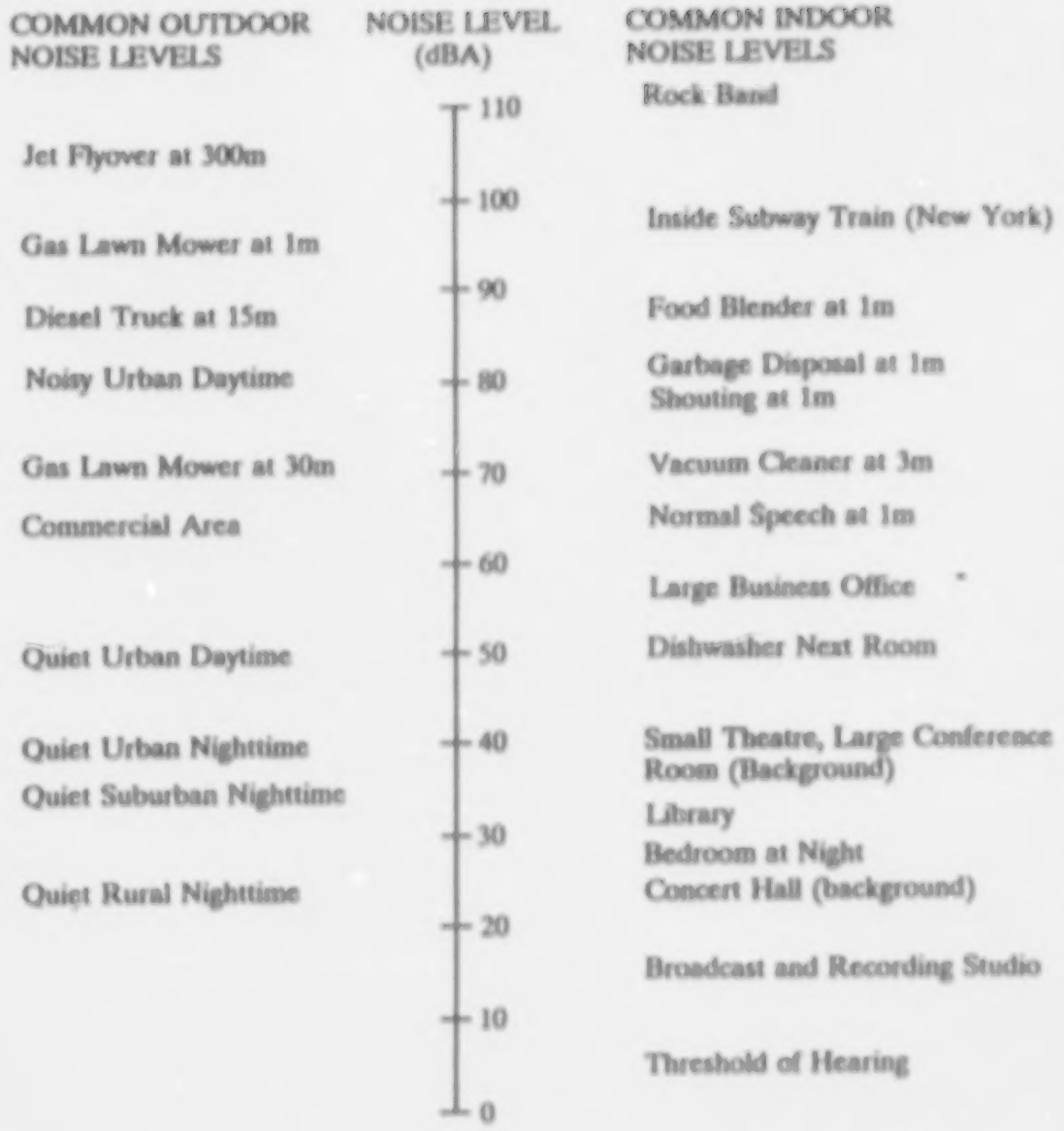

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FIGURE 2-6
COMMON INDOOR AND OUTDOOR NOISE LEVELS

JUNE 1990

TABLE 2-5

Noise Monitoring Summary - Average Leq

Stat. No	Results for Month (L_{eq}, dBA) Jan	Feb	Mar	Apr	May	June	Min.	Max.
1	43	52	56	52	50	51	46	57
2	44	50	50	51	49	50	44	55
3	55	46	43	47	42	42	35	55
4	39	46	46	48	43	46	38	64
5	40	48	49	51	46	47	39	64
6	57	49	60	59	55	56	53	60
7	53	56	57	60	54	56	52	62
8	56	56	53	59	56	56	53	58
9	57	53	54	53	49	50	45	59
10	58	57	56	59	56	57	55	59
11	n/a	58	59	62	64	62	60	64
12	50	47	50	49	48	51	43	58
13	n/a	n/a	53	52	49	48	45	55
13A	n/a	n/a	56	53	51	51	47	55

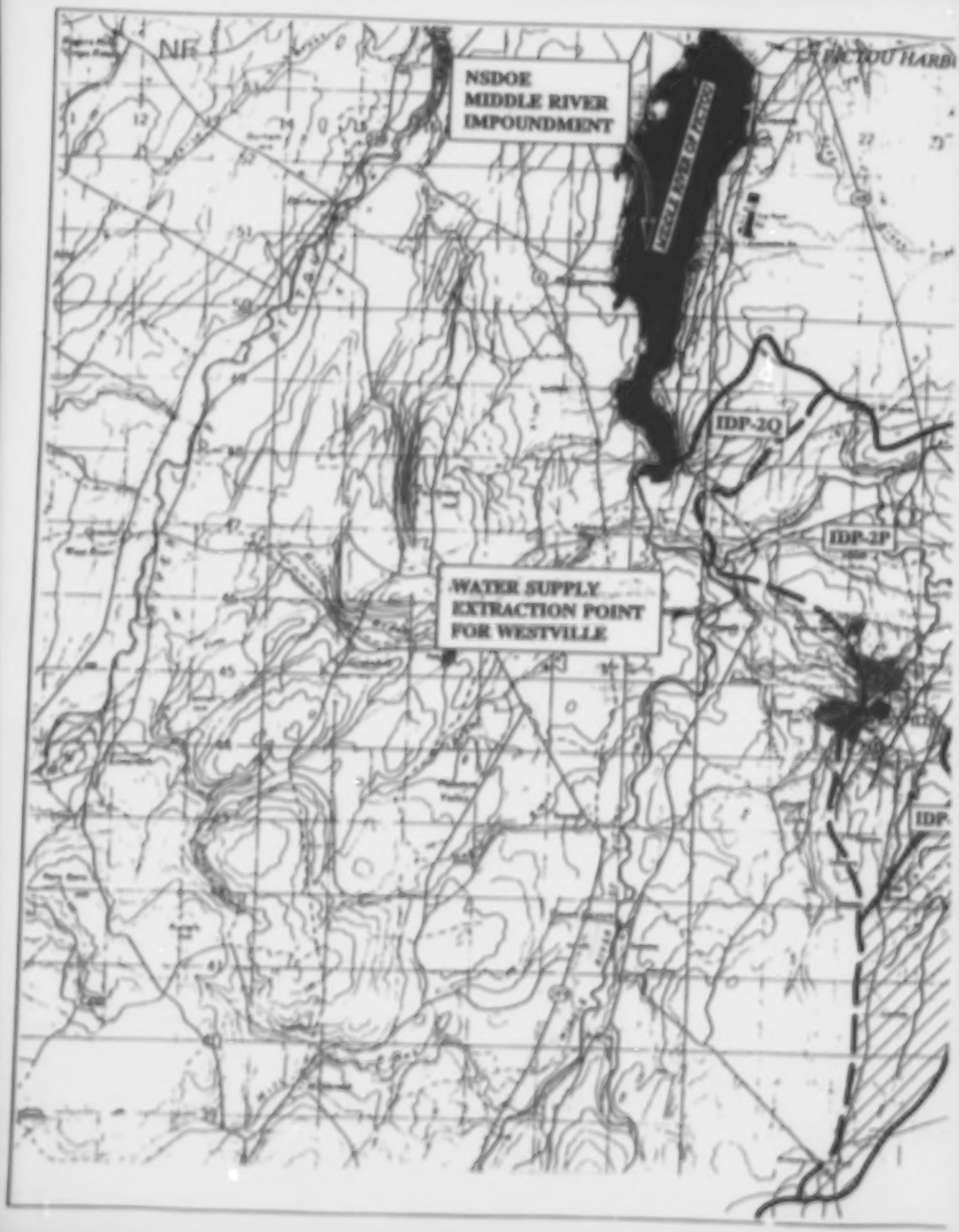
2.4 Surface Water Environment

2.4.1 Hydrology

The proposed mine area spans the watershed divide for two regional provincial watersheds, (Figure 2-7), specifically:

- The Middle River watershed, No. IDP - 2, and
- The East River watershed, - No. IDP - 3.

Since the receptor stream for the site drainage flows to the Middle River, (see Section 1.4), only it has been assessed in the following discussion.


NSDOE
MIDDLE RIVER
IMPOUNDMENT
IDP-2Q
IDP-2P
WATER SUPPLY
EXTRACTION POINT
FOR WESTVILLE

LEGEND

- REGIONAL WATERSHED DIVIDE
- BEAR BROOK SUBWATERSHED DIVIDE
- PROPOSED SITE (APPROXIMATE)
- DRAINAGE AREA ABOVE PROPOSED SITE RUNOFF DISCHARGE POINT
- PERTINENT WATERCOURSES
- LOCATION OF DISCHARGE POINT FOR SITE DRAINAGE
- LOCATION OF PIONEER COAL STRIP MINE

Scale

0 1.0km 2.0km

FIGURE 2-7
LOCAL HYDROLOGY

NOLAN, DAVIS & ASSOCIATES

Drawn By: TB	Checked By: FEB
Date: June 1992	Project No. H92561

The Middle River is a north-south oriented watershed draining principally the Carboniferous sediments of the Pictou Basin. It drains northward discharging initially into the estuarine environment of Pictou Harbour and then into the marine environment of the Gulf of St. Lawrence-Northumberland Strait. It has a drainage area of 234 km^2 and ranks as the fourth largest drainage basin in Pictou County. It has a large (approximately 54 hectares) impoundment constructed on it between the Bear Brook confluence and the Harbour.

The mine site is located within provincial Subwatershed IDP-2P (Figure 2-7). Existing mapping has referenced this watershed as McCulloch, Fox or Bear Brook. For the purposes of this investigation it will be designated as Bear Brook. It drains northward, entering the Middle River some 2.4 kilometres upstream from its mouth.

2.4.1.1 Receptor Stream Designation

Although the proposed site is positioned within two watersheds, operational plans designate that the site drainage can be directed westward to discharge into Bear Brook, which is therefore identified as the receptor stream for this Preliminary Report (see Section 1.4). The present discharge point is approximately 7 kilometres upstream from the Middle River confluence.

2.4.1.2 Drainage Basin Morphology

The Bear Brook watershed exhibits a narrow, "V" shaped plan profile and encompasses an area of 2625 hectares, based upon 1:50,000 scale mapping. The basin storage (lake) component is negligible at less than one percent. The drainage basin upstream of the discharge point is approximately 1103 hectares or 42 percent of the total watershed. This calculation encompasses the entire mine site and therefore locally exceeds the natural basin divide.

The Bear Brook watershed comprises 11.8 percent of the 222 km^2 Middle River drainage basin calculated at the confluence with Bear Brook. The north-south

orientation of the watershed parallels the regional trend and topographic slope; which is generally at a 45 degree angle to regional bedrock strike. The drainage density for the Bear Brook watershed is approximately 1km/km^2; and is therefore categorized as poorly drained.

2.4.1.3 Channel Morphology

The Bear Brook watershed exhibits a generally straight to irregular, single channel system with minimal laterals. The Shrieve Stream order for the Brook channel at the confluence with the Middle River is 10 from 1:50,000 scale mapping; the Middle River is a 62nd order channel. At the confluence with the proposed site runoff the Bear Brook channel is a 6th order reach.

A traverse down Bear Brook from Acadia Avenue to the confluence with the Middle River indicated the closest bedrock outcrop in the stream bed to the proposed site was positioned some 250 metres downstream of Highway 289. This 45 metre reach positions the exposure stratigraphically above the Foord Seam and thus within the zone of influence of the stripped strata on-site. Upstream of this reach the channel is apparently underlain by the till. Progressing downstream, bedrock exposures increase in frequency down to the mouth.

A large beaver dam was in evidence some 250 metres upstream of the sewage outfall. A number of minor dams were also in evidence upstream of this position.

Natural submergence of the shoreline which exists throughout Nova Scotia due to post-glacial sea rise has "drowned" the lower reaches of the Middle River. Given the present rate of rise of approximately 0.3 metres/100 years, the influence of this submergence, and therefore tidal activity is gradually progressing upstream. The impoundment on the Middle River at Granton curtails tidal and salt water influences in the river at the Bear Brook confluence.

2.4.1.4 River Basin Activities

The Bear Brook drainage basin exhibits a full range of land use typing from natural to suburban, urban, industrial, commercial, mining, transportation and regrowth on abandoned farm land and/or forestry cuts. The major alterations include approximately 40 kilometres of roads, 1 kilometres of railine and 10 hectares of commercial land. In addition there are some 100 residences within the drainage area positioned primarily as ribbon development along the major transportation corridors. A number of these residences are on individual septic fields.

The Town of Westville utilizes the Middle River as their water supply; the extraction point being one kilometre upstream from the Bear Brook confluence.

A dam was constructed on the Middle River in the mid 1960's to create a freshwater impoundment. The dam and upper extent of the impoundment are located approximately 8.3 and 1.9 kilometres respectively downstream of the Bear Brook/Middle River confluence respectively. The NSDOE Utilities Branch operates a pumping facility at Granton which supplies untreated freshwater from this impoundment to Scott Maritimes and the Michelin Tire Plant at Granton. Withdrawals are up to 119 million L/day and approximately 3.8 million L/day respectively.

There is one industrial waste discharge permit filed with NSDOE for Bear Brook in addition to that for Westray. It allows for the discharge of treated municipal sewage for the Town of Westville; the outfall being located some 890 metres downstream from the existing site runoff discharge point (see Figure 1-15) and upstream of the proposed second discharge point.

There have been no water rights permits issued by NSDOE for surface water withdrawals within the Bear Brook watershed. No door-to-door assessments have been undertaken to determine if any individual residences utilize the Brook for a water supply downstream of the proposed site.

Storm sewers in Westville discharge into three watercourses which enter Bear Brook immediately downgradient of the study area. The stream traverse identified debris from previous abandoned mining activity in the vicinity of the outfalls.

2.4.1.5 Water Flows

There has been no known monitoring of flows within Bear Brook. It is expected for order-of-magnitude purposes that discharges for the entire watershed will be "flashy" in nature (i.e., respond quickly to rainfall events) with high runoff coefficients and reduced base flows. This conclusion is based upon:

- the dominance of variable source storm flow,
- the low permeability of the till and bedrock
- the absence of major storage (lakes) components and the impact of urban - suburban land use associated with Westville.

An Environment Canada automated discharge gauging station is located on the Middle River at Rocklin on a 44th order reach, with a drainage area of 92.2 km^2. It has been operational since 1965. Gibb et al (1960) have indicated that there was evidence to support the use of unit discharges from this gauging station to other basins in the area. Further they noted that the hydrograph revealed a "flashy" response to rainfall events with a relatively low baseflow component. This was attributable to steep basin topography and lack of storage.

A theoretical range of flows was generated for the Bear Brook drainage basin upstream of the existing mine site discharge point utilizing Middle River runoff coefficients (developed from 24 years of records). The calculations indicate a mean annual flow of 0.33 m^3/sec; with a range from 0.21 - 0.46 m^3/sec. Summer monthly mean daily flows during the low flow period in July, August and September could be expected to range from 0.10 to 0.13 m^3/sec. During the Fall rains and spring melt these values could rise to a range of 0.50 to 0.95 m^3 /sec.

2.4.1.6 Water Chemistry

Stipulations set out in the NSDOE Application for Approval of Industrial Waste Treatment Works (File No. 11-91-0090, Approval No. 91-081 dated January 2, 1992) for the Coal Bulk Sampling Program indicated liquid effluent from the settling ponds was to be monitored for the criteria set out if Section 7 i) of the Application (see Table 1-5).

In addition to the settling pond discharge monitoring, the water chemistry of Bear Brook was also monitored during the Bulk Sampling Program. The water chemistry monitoring data is presented in Table 2-6. This data suggests that Bear Brook exhibits a near neutral pH range (6.5-7.8) and can be characterized as fresh (ion sum 42-210 mg/l), very soft to moderately soft, slightly to moderately coloured, non-turbid, mixed sodium/calcium-bicarbonate/chloride/(Na/Ca-CO_3/Cl) type waters (Figure 2-8). Data for the major ion chemistry typing wes derived from surface water samples collected from Stations 1, 2, 4, 5 on Bear Brook (Figure 2-9) from mid-March 1992 to late May 1992.

The above-noted surface water monitoring program has recently been upgraded to include the Middle River. This Ambient Trend Surface Water Monitoring Program was incorporated to monitor any changes to the Middle River system resulting from the mine operation.

The location of the Ambient Trend Surface Water Monitoring stations are shown in Figure 2-9. The program has been initiated and the data currently available are reported in Table 2-7. This program will be continued as part of the ongoing monitoring proposal in Part Five of the report.

Although the water chemistry monitoring for the Middle River has been more frequent and for a wider range of variables, the data for Bear Brook generally complies to the existing water quality data for the Middle River.

TABLE 3-8

Doe Green Water Quality Monitoring Data

Bulk Sampling Program

	pH	S.S.	N	Iron	Oil	Sodium	Potassium	Calcium	Magnesium	Alkalinity	Sulfate	Chloride	Silica	Dilbo (Phosphorus)	Chloro (Chloride)	Ammonia	Manganese	Copper	Zinc	Colour	Turbidity	Specific Conductance	Total Organic Carbon	Hardness	Iron Bulk
[illegible]																									
[illegible]																									
[illegible]	7	13.5	0.32	0.44	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	6.8	15.0	0.29	0.37	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	6.9	5.0	0.30	0.35	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	6.7	6.0	0.33	0.39	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]																									
[illegible]	6.8	21.0	0.35	0.41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	6.8	25.0	0.41	0.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	6.7	18.0	0.40	0.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	6.8	19.0	0.38	0.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]																									
[illegible]	6.8	5.8	0.27	0.34	<1	3.0	0.8	0.10	1.0	0.0	0.0	17.0	2.1	<0.01	<0.05	<0.05	0.04	<0.01	<0.8	10	0.25	73.0	2.4	12.0	43.0
[illegible]	6.9	15.2	0.28	0.35	<1	16.0	2.1	15.4	2.8	10.0	44.0	29.4	2.0	<0.01	0.71	<0.05	0.01	<0.01	<0.8	7	13.0	325.0	2.2	38.0	128.4
[illegible]																									
[illegible]	6.8	37.0	0.17	0.17	-	3.4	0.8	6.1	1.4	7.0	13.0	13.4	1.7	<0.01	0.42	0.09	0.10	<0.01	<0.8	15	1.05	65.1	2.2	19.0	48.8
[illegible]																									
[illegible]	7.0	13.0	0.33	0.45	<1	14.2	2.7	21.0	4.8	41.0	39.0	27.4	2.4	0.05	0.05	1.04	0.24	0.01	<0.8	27	2.72	405.0	6.8	73.1	215.2
[illegible]	7.0	15.8	0.30	0.70	<1	25.6	3.0	25.1	4.8	34.0	27.0	31.8	3.0	0.05	0.05	0.72	0.18	0.01	<0.8	23	3.40	350.0	7.4	89.1	185.0
[illegible]	7.0	4.8	0.28	0.33	<1	15.0	3.8	16.1	3.0	25.0	28.0	19.4	2.0	0.05	<0.05	0.26	<0.01	<0.01	<0.8	20	2.8	150.0	4.0	51.7	125.2
[illegible]	7.0	6.0	0.30	0.38	<1	19.4	3.8	19.8	3.4	28.0	27.0	17.7	2.0	0.05	<0.05	0.29	<0.01	<0.01	<0.8	25	3.07	181.0	4.0	73.4	89.0

Note:

Bee Green side known mostly as Fox Brook and Abe/Lothard Green.

Compliance monitoring station at point of discharge from settling pond to Elk Lk

(Designated #2) in Application for Approval of Industrial Water Treatment Plants.

Elk – 1 Surface Water - Sample Station No. 1 (Refer to Figure 3-6).

-- Not analyzed

All concentrations in milligrams per litre (mg/l) except for pH.

Colour (True Colour Units), Turbidity (Nephelometric Turbidity Units),

Specific Conductance (Microsiemens per centimetre).

S.S. Suspended Sediment

Al Aluminum

[illegible]

[illegible]

[illegible]

	Mg	K	Ca	Mg	Mn	Zn	O	Al2o3	Sr(Mg) Phosphate	Rb2o + Cl2o5	Al2o3	Ga	Sr	Ba(n)	Zr	Sn
a) Gr. (Mg)																
1	37.1	1.2	24.7	3.3	49	31	35.2	3.2	<0.01	0.47	<0.01	-	0.22	<0.01	<0.01	<0.01
2	34.1	3.2	23.2	7.8	74	43	35.3	2.9	0.23	0.12	0.31	-	0.12	0.22	<0.01	0.25
3	35.8	3.1	27.8	3.4	72	37	35.9	2.7	0.44	0.11	0.25	-	0.42	0.29	<0.01	<0.01
4	28.4	3.5	71.1	17.8	329	177	29.3	0.9	0.21	0.43	1.43	-	0.23	0.17	<0.01	0.04
5	31.3	3.7	30.7	3.3	47	27	35.2	3.6	0.01	0.45	<0.01	-	0.32	<0.01	<0.01	<0.01

a

Sulfuric (Diorite) | S. Perennial (NEO Gabbro) | Cu. Calcium | Cr(). Cruor-Hydrogen | Hg. Magnesium | Arb. Alkaliferic | Ca. Gab | Sr(N. Sulfuric | Sb(Mg)Sulfuric | Ga. Cruor | Al. Aluminum | Sr. Zinc

(Cont'd)

a Brook, the leaves (acid) or Fox Brook, salt Anachronism Brook.

measurements is milligrams per liter (mg/l), except for pH.

Gm (Fine Glitter Acid), Turbidity (Predominants Turbidity Units),

with Conformism (ammonium per membrane), Fiber Sure (Some per second),

acts grazing

samples left Charred after 0.0. downplanetlines

n - Not available

TABLE 3-1 (Cont'd)

Additional Treated Water Quality Monitoring Data

Deer Brook/Middle River

	Colour	Turbidity	Specific Conductivity	Total Organic Carbon	Hardness	Iron		Field pH	Lab pH	Field Temp	Dechlorinated Flow Rate
Date (D - MM)											
1	10	1.26	262	4.2	80.2	170	-	7.0	7.2	17	75
2	10	0.42	267	7.0	77	286	-	7.2	6.7	15	111
3	10	0.97	277	6.8	81.1	272	-	7.1	7.0	15	472
4	11	1.29	276	5.0	84	1140	-	7.0	7.0	15	214
5	9	0.28	276	5.2	83.2	79	-	7.1	7.2	15	814

Note:

Fe: Sulfur — S: Fluoride — Ca: Calcium — Mg: Magnesium — Al: Aluminum — Si: Silica — S.E.: Evaporated Salt Spoon — Cl: Chloride — Alk: Alkalinity — T.N.: Total Nitrogen — Fe: Iron — Mn: Manganese — Cu: Copper — Sr: Size

Deer Brook site (across bank) is Pre-Brook and Turret Creek Brook

All measurements in milligrams per litre (mg/l) except for pH.

Colour (True Colour Units), Turbidity (Nephelometric Turbidity Units),

Specific Conductance (microsiemens per centimetre), Flow Rate (Litres per second),

- results pending

All samples last Elected prior to S.E. determinations

N.A. - Not available

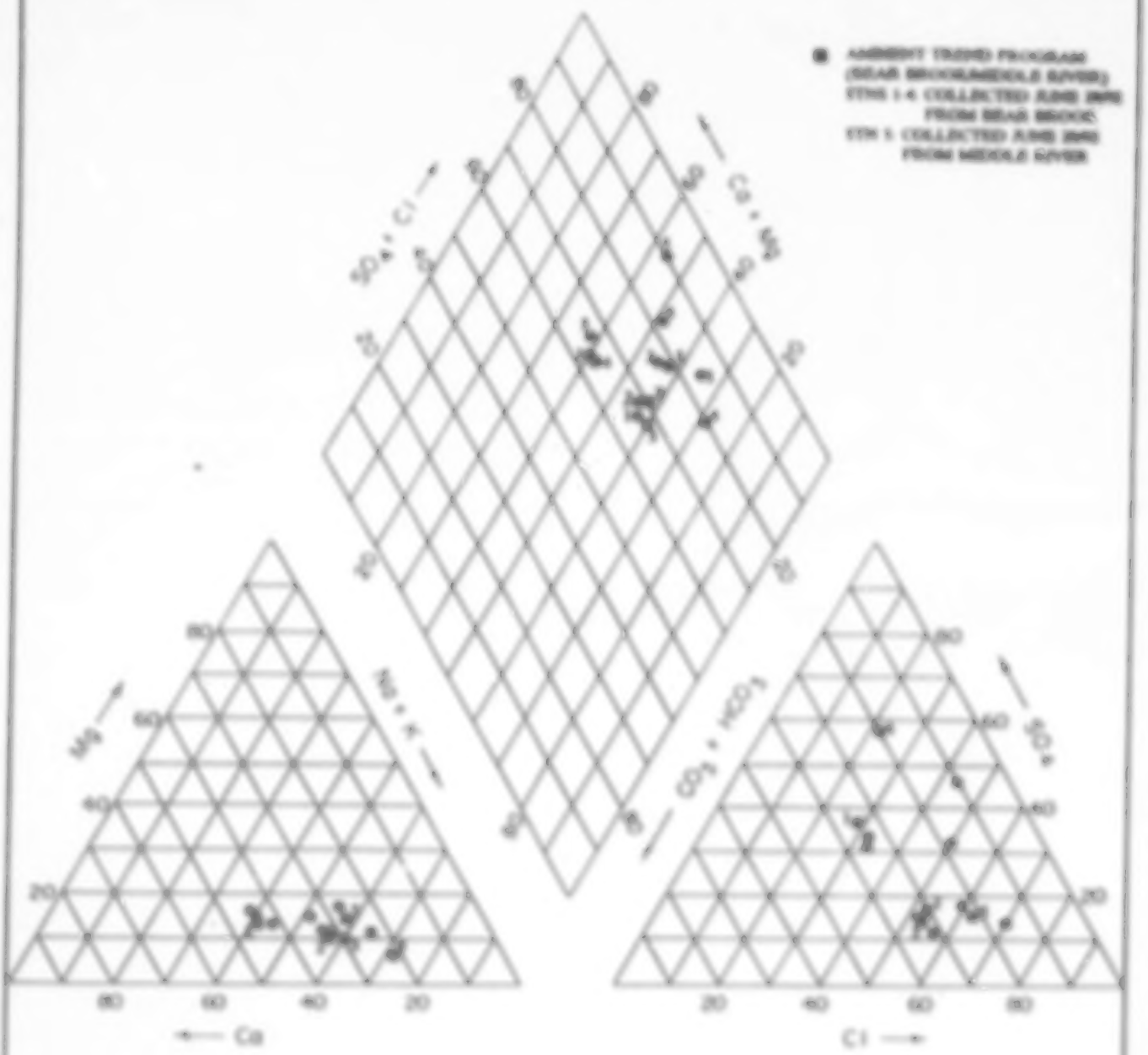


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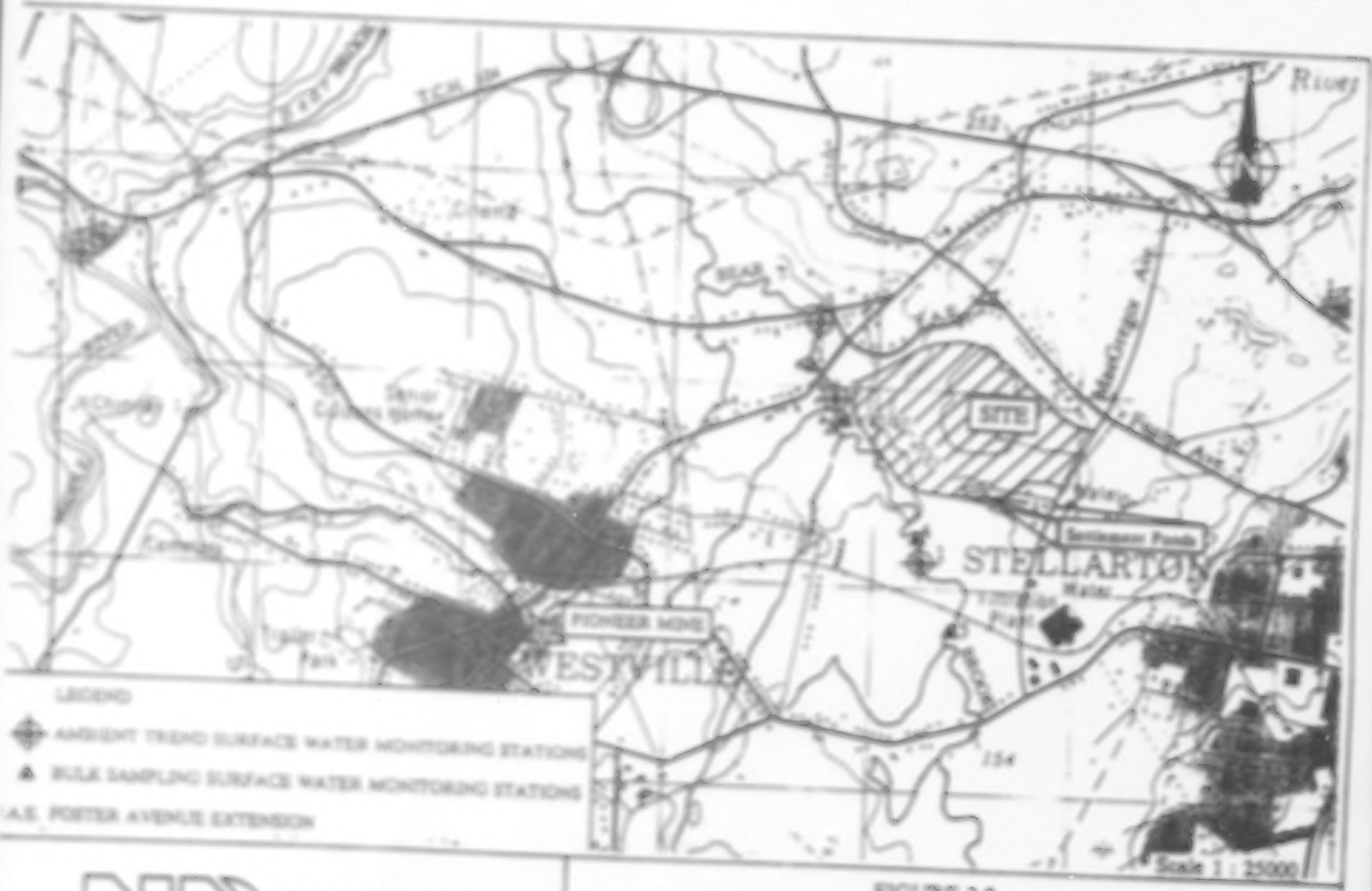
FIGURE 2-8
TRILINEAR DIAGRAM
MAJOR ION CHEMISTRY
BEAR BROOK/MIDDLE RIVER



LEGEND

◆ AMBIENT TREND SURFACE WATER MONITORING STATIONS

▲ BULK SAMPLING SURFACE WATER MONITORING STATIONS

A.E. FOSTER AVENUE EXTENSION

NOLAN, DAVIS & ASSOCIATES

FIGURE 2-9
SURFACE WATER MONITORING STATIONS
STELLARTON PIT MINE
PICTOU COUNTY, N.S.

The data generated by Environment Canada at their gauging station at Rocklin between 1969 and 1977 is summarized in Table 2-8. The water can be characterized as fresh slightly coloured, non-turbid, soft, mixed Na/Ca-CO_3/Cl type water near neutral pH.

The Wimpey surface water quality testing included two sampling events in June and July, 1977. Total iron, stream suspended sediments and pH are common variables analyzed for the 1977 and on-going 1992 surface water quality monitoring. The range of concentrations of these parameters are comparable for both sampling events (1977 & 1992).

2.4.2 Sedimentology

This section addresses the transport of particle sizes exceeding 0.45 microns within the Basin. Using the method set out by Leopold (1964) (see Figure 2-10), the study area can be categorized as lying in a region where mechanical and chemical weathering are the dominant weathering processes. These are followed in order by running water and mass movement erosion processes.

2.4.2.1 Erodability

The till sheet overlying the project area is Eatonville basal till (Stea and Myers, 1990). Grain size data collected on this till sheet at the Plymouth site was utilized to derive worse case inherent erodability (K) factors (Wischmier et al, 1965) for the till on-site. The K values range between 0.45 - 0.70, and are therefore classified as having "very high erodability". However, based on a preliminary assessment using the Langbein and Schumm (1958) methodology (Figure 2-9), it is expected that natural physical sediment yields in the study area would be approximately 100 t/km ^{2}/yr (tonnes per square kilometres per year).

Sediment yields have not been determined for the mine site as they would be of limited value due to the fact that runoff will be totally controlled by the drainage system and treatment ponds described in Section 1.4. However, work on wooded watersheds in Maryland under similar geological, climatic and vegetation conditions, indicated a sediment yield encompassing land and channel based erosion of approximately 13-39 t/km^2 /yr

TABLE 2-8

Water Chemistry for Middle River at Rocklin (Cont'd)

	UNITS	SAMPLES	FLAGS	AVERAGE	STD. DEV.	MEDIAN	HIGH	DETECTION LIMIT
Zinc (Extractable)	mg/L	26	10	0.012	0.021	0.009	0.11	0.001
Arsenic (Total)	mg/L	4	1	0.007	0.004	0.006	0.013	0.005
Molybdenium (Extractable)	mg/L	2	2	LTO.0002			LTO.0002	0.0002
Silver (Extractable)	mg/L	2	2	LTO.005			LTO.005	0.005
Cadmium (Extractable)	mg/L	16	12	0.002	0.002	LTO.001	LTO.01	0.001
Barium (Extractable)	mg/L	2	2	LTO.1			LTO.1	0.1
Mercury (Extractable)	ug/l	15	10	0.05	0.01	LTO.05	0.10	0.05
Lead (Extractable)	mg/l	18	9	0.003	0.002	0.002	0.010	0.001
p.p.-DDT	ug/l	2	2	LTO.010			LTO.010	0.010
o.p.-DDT	ug/l	1	1	LTO.005			LTO.0005	0.005
p.p.-TDE	ug/l	2	2	LTO.005			LTO.0005	0.005
p.p.-DDE	ug/l	2	2	LTO.005			LTO.0005	0.005
p.p. - methoxychlor	ug/l	2	2	LTO.005			LTO.0005	0.005
Heptachlor	ug/l	2	2	LTO.005			LTO.0005	0.005
Heptachlor expocide	ug/l	2	2	LTO.005			LTO.0005	0.005
alpha-BBC	ug/l	2	2	LTO.005			LTO.0005	0.005
alpha-Endosulphan	ug/l	2	2	LTO.005			LTO.0005	0.005
beta-exndosulpahn	ug/l	2	2	LTO.005			LTO.0005	0.005
alpha (cis) chlordane	ug/l	2	2	LTO.005			LTO.0005	0.005
gamma (trans) chlordane	ug/l	2	2	LTO.005			LTO.0005	0.005
gamma-BHC (Lindane)	ug/l	2	2	LTO.005			LTO.0005	0.005
Aldrin	ug/l	2	2	LTO.005			LTO.0005	0.005
Endrin	ug/l	2	2	LTO.005			LTO.0005	0.005
HSOD (Dieldrin)	ug/l	2	2	LTO.005			LTO.0005	0.005
Nitrogen (Total Kjeldahl)	mg/l	2	2	LTO.5			LTO.5	0.5
Nitrogen (Dissolved NO3 & NO2)	mg/l	69	7	0.070	0.053	0.059	0.226	
Nitrogen (Dissolved Ammonia)	mg/l	32	11	0.102	0.121	LTO.100	0.500	0.005

(Cont'd)

TABLE 2-8

Water Chemistry for Middle River at Rocklin (Cont'd)

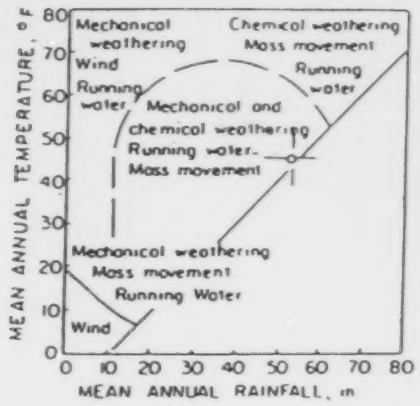
	UNITS	SAMPLES	FLAGS	AVERAGE	STD. DEV.	MEDIAN	HIGH	DETECTION LIMIT
Phosphorus (Total)	mg/l	17	4	0.009	0.006	0.006	0.023	
Carbon (Total Organic)	mg/l	15	0	4.3	1.5	4.1	7.4	
Humic Acid	mg/l	1	0					
Chlorophyll A	mg/m3							
Residue (Nonfilterable)	mg/L	4	0	11	8	9	22	
Residue (Fixed Nonfilterable)	mg/L	3	0	7	7	4	15	
Residue (Filterable)	mg/L	3	0	40	6	40	45	
Residue (Fixed Filterable)	mg/L	3	0	25	1	25	26	
Silica (Reactive)	mg/L	61	0	3.0	0.7	2.9	4.9	
Fluoride (Dissolved)	mg/L	26	19	0.08	0.03	LTO.10	0.13	0.05
Boron (Dissolved)	mg/L	2	2	LTO.02			LTO.02	0.02
Chronium (Extractable)	mg/L	2	1	0.0047	0.0060		0.009	0.0005
Manganese (Dissolved)	mg/L	18	15	0.011	0.003	LTO.010	0.020	0.010
Manganes (Extractable)	mg/L	23	6	0.02	0.02	0.02	0.009	0.01
Iron (Dissolved)	mg/L	17	1	0.032	0.026	0.020	0.110	0.001
Iron (Extractable)	mg/L	22	0	0.121	0.052	0.110	0.240	
Cobalt (Extractable)	mg/L	2	1	0.002	0.002		0.004	0.001
Nickel (Extractable)	mg/L	2	0	0.007	0.006		0.011	
Copper (Extractable)	mg/L	25	16	0.009	0.015	LTO.002	0.07	0.001
Specific Conduct.	USIE/cm	70	0	63	27	55	164	
Turbidity	JTU	70	4	2.1	4.0	1	28.0	0.1
Colour (Apparent)	Rel units	70	4	13	11	10	60	5
pH	pH units	70	0			6.8	7.7	
Alkalinity (Total)	mg/L	71	0	10.3	4.7	9.1	22.8	
Alkalinity (Phenol Phthalein)	mg/L	72	0	0.0	0.0	0.0	0.0	

(Cont'd)

TABLE 2-8

Water Chemistry for Middle River at Rocklin

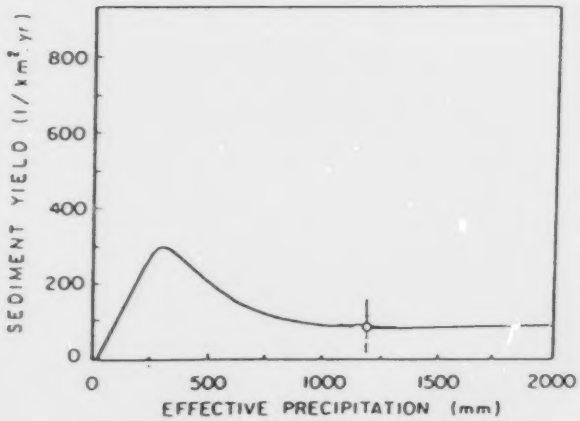
	UNITS	SAMPLES	FLAGS	AVERAGE	STD. DEV.	MEDIAN	HIGH	DETECTION LIMIT
Total Dissolved Solids	mg/L	66	0	32	13	28	80	
Sodium (Dissolved)	mg/L	72	0	5.4	3.4	4.2	20.0	
Potassium (Dissolved)	mg/L	70	0	0.6	0.2	0.5	1.5	
Calcium (Dissolved)	mg/L	71	0	4.3	1.8	3.8	10.1	
Magnesium (Dissolved)	mg/L	51	0	1.4	0.4	1.3	2.3	
Carbonate (Calculated)	mg/L	71	0	0	0	0	0	
Bicarbonate (Calculated)	mg/L	71	0	13	6	11	28	
Chloride (Dissolved)	mg/L	70	0	8.1	4.8	7	26.0	
Sulphate (Dissolved)	mg/L	70	0	6.9	2.6	6.3	14.6	
Saturation Index (Calculated)	pH units	65	0			-3.1	-1.6	
Stability Index (Calculated)	pH units	65	0			13.0	15.1	
Sodium Absorption Ratio	Rel units	70	0	0.53	0.18	0.48	1.3	
Oxygen (Dissolved)	mg/L	13	0	11.6	1.9	0.6	14.2	
Oxygen (Dissolved Saturation)								
Oxygen (Total COD)	mg/L							
Oxygen (Consumed)	mg/L	10			2.1	5.0	7.6	



MORPHOGENETIC REGIONS

The possible relative importance of specific weathering and erosional processes is indicated by the order in which they are listed.

⊕ indicates location of study area
(after Leopold et al, 1967)



GENERAL GLOBAL RELATIONSHIPS
BETWEEN YIELD AND ANNUAL PRECIPITATION

⊕ indicates location of study area
(after Langbien and Schuum, 1958)

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FIGURE 2-10
MORPHOGENETIC REGIONS &
YEILD - PRECIPITATION RELATIONSHIPS

JUNE 1992

H92561

(Wolman, 1967). This rate is similar to values noted in the Sydney Coalfield (NDAL, 1981; Baechler, 1986). This reduced loading rate may be partially due to reduced sediment delivery ratios resulting from the coarse drainage texture. Preliminary suspended sediment concentrations collected by Westray for Bear Brook upstream from the site discharge point indicated a range of 4.4-16 mg/L which could tend to support the assumption of a lower loading rate range than that initially estimated (ie less than 100 t/km^2/yr.).

2.4.3 Sediment Geochemistry

Regional stream sediment geochemistry sampling has been undertaken by the N.S.D.N.R. Data for the till or bedrock units is not included in this report. Sampling by Rogers and MacDonald (1986) noted that elevated metals (mercury, lead, copper and zinc) were found in two streams. One sample site was positioned on Bear Brook below the treatment plant outfall, a second on a tributary near the Pioneer mine site. The data available are presented in Table 2-9.

2.4.4 Aquatic Biology

For this assessment, information on the Middle River and Pictou Harbour has been largely based on a preliminary environmental profile prepared for Environment Canada (Seakem Oceanography Ltd., 1990), along with recent fisheries statistical information obtained from Fisheries & Oceans Canada, and water quality data from Environment Canada. Information on Bear Brook was obtained from field surveys conducted on January 14 and May 22, 1992 and from discussions with Fisheries & Oceans Canada personnel responsible for the area.

2.4.4.1 Overview

Pictou Harbour constitutes the estuary formed at the junction of the East, Middle and West rivers. The surface salinity of this estuary gradually decreases inland from the outer harbour. Available information suggests that the biological conditions of the harbour are similar to other estuaries in the region.

TABLE 2-9
Stream Sediment Geochemistry Data
Bear Brook

	Zn	Cu	Pb	Ni	Co	Ag	Mn	As	Mo	Fe	Hg	U
SAMPLE LOCATION												
Below Sewage Treatment Plant	280.0	16.0	65.0	24.0	13.0	0.1	780.0	5.5	1.0	2.95	40.0	2.3
Second Tributary near Pioneer Mine	910.0	21.0	152.0	19.0	15.0	0.1	1500.0	11.0	2.0	3.1	80.0	2.7

adapted from Rogers and MacDonald, 1986

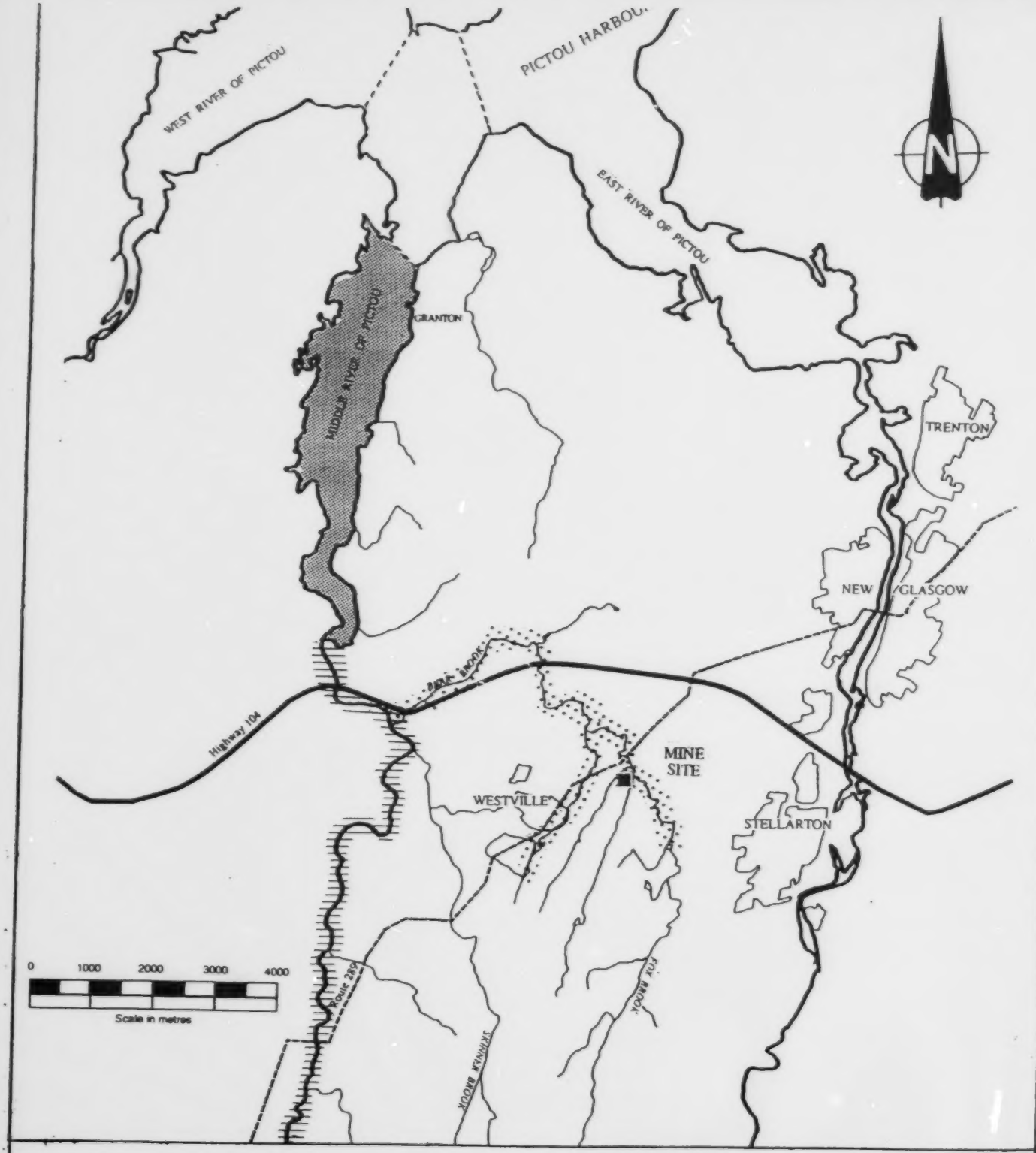

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FIGURE 2-11
IMPORTANT AQUATIC RESOURCES

Shellfish (oysters, blue mussels, softshell clams and lobster) and finfish (gaspereau, smelt, mackerel and eel) are important commercial species found in the harbour. At present the Harbour is closed to commercial harvesting of shellfish, but collection for recreational purposes and commercial depuration are allowed.

An important fishery for gaspereau developed in the estuary, initially as a result of additional spawning habitat created by the freshwater impoundment behind the Harbour causeway in the early 1960s. Subsequently, salt water was allowed to enter the area behind the causeway, which led to modifications to the Middle River dam (near Granton) to allow gaspereau passage into this freshwater impoundment for spawning (Figure 2-11). Landings of almost 1,000 tonnes with values up to a quarter of a million dollars have been reported in recent years. In 1991, the commercial gaspereau fishery reported landings of 280 tonnes with a value of close to $75,000 (Preliminary statistics, Fisheries & Oceans Canada, Gulf Region). Commercial smelt fishing sites and eel fyke nets also occurs near the mouth of the rivers but contribute little to the overall landings and values. Lobster provides the largest landed value in the Pictou area, with landings of up to a million kilograms per year and values up to six million dollars. Lobster, along with rock crab, and scallop landings represent, for the most part, catch from outside Pictou Harbour.

The three rivers, the East, West and Middle, flow predominantly through wooded terrain with small amounts of cleared land. The waters of the rivers are soft with slight to moderate colour and approximately neutral pH. The East River of Pictou has remained a significant salmon river while the numbers of salmon had precipitously declined in the West and Middle Rivers. Design problems with the fishway at the Middle River dam have been cited as the reason for the decline in salmon in the Middle River. However, the modifications performed on the structure in 1986 and 1987 and recent stocking have led to initial increases in numbers of salmon in the Middle River. Along with salmon, other recreational fish species reported in the area are brook, rainbow and brown trout, yellow and white perch, smelt, shad and striped bass.

Water quality surveys of the Middle River in 1988 and 1989 showed significant nutrient loading (orthophosphate, nitrate-nitrite and ammonia) and evidence of bacterial contamination from malfunctioning sewage disposal systems and possibly agricultural-related activities on Bear Brook.

Bear Brook is about 12 kilometres long, running between the Towns of Westville and Stellarton for most of its length. A survey of the fish habitat on the Brook from the Highway 289 bridge upstream to the CN Rail crossing was completed on January 14, 1992. The air temperature was about 5°C for most of the afternoon, cooling towards the evening. The water temperature of the brook was 0.5°C at the Route 289 bridge and near 0°C about 300 m upstream of the bridge (upstream of the sewage treatment plant discharge). A second survey of the fish habitat on Bear Brook from approximately 100 metres upstream of the sewage treatment plant downstream to the mouth was completed on May 22, 1992. This second survey only examined sections of the Brook near road crossings to identify the extent of siltation of fish habitat observed in the lower Brook. The air temperature was approximately 30°C and the water temperature at the mouth of Bear Brook was 17°C. As part of the survey electrofishing was performed to determine the fish species present, specifically the presence or absence of brook trout. The results of the electrofishing are summarized in Table 2-10.

2.4.4.2 Recreational Fisheries

Brook trout are the most important recreational fish species in the Middle River and its tributaries, but spawning to support this population is likely concentrated in the smaller brooks, including headwater streams. Estimates of Brook trout catch or fishing effort are not available for individual rivers, but approximately 5,000 trout are reported caught in Pictou County every year.

Atlantic salmon are more dependent on the larger main river than small tributary streams. Salmon had disappeared from the Middle River for many years but recent fish passage improvements and stocking have resulted in returns of adult salmon. In

1991, 55 salmon were counted passing upstream into the Middle River at the Granton dam (MacInnis, pers. comm.). This was also the first year that angling for salmon was reported on the Middle River with an effort of 4 rod-days resulting in the catch and release of one adult salmon. In comparison, a fishing effort of 1,526 rod-days on the East River and 641 roddays on the West River was reported in 1991 (Fisheries & Oceans Canada Sport Catch Statistics).

Salmon enhancement efforts on the Middle River have concentrated on the annual stocking of unfed fry in late May since 1989 (Parsons, pers. comm.). Between 1,000 and 2,000 of these fry have been stocked between the inflow of Bear Brook and the mouth of Middle River in the last few years; about 20,000 fry have been stocked between Union Centre and the river mouth. The remainder have been introduced in more upstream sections of the river, primarily downstream of Rocklin. Stocking has steadily increased from 36,400 fry in 1989 to 56,840 in 1992.

TABLE 2-10

Electrofishing Results for Bear Brook, Pictou County
May 22, 1992

Location	Species	Nos.	Length (cm)
50-100 m upstream from sewage discharge	white sucker *(Catostomus commersoni)*	7	3 - 7
	white sucker *(Catostomus commersoni)*	2	10 - 13
	white sucker *(Catostomus commersoni)*	1	20 - 21
	white sucker *(Catostomus commersoni)*	1	35 - 36
100 m downstream to Hwy. 104 bridge	creek chub *(Semotilus atromaculatus)*	6	2 - 4
	creek chub *(Semotilus atromaculatus)*	1	05 - 8
	ninespine stickleback *(Pungitius pungitius)*	1	2 - 3
	threespine stickleback *(Gasterosteus aculeatus)*	1	2 - 3
	threespine stickleback *(Gasterosteus aculeatus)*	1	5 - 6
	white sucker *(Catostomus commersoni)*	3	3 - 4
	white sucker *(Catostomus commersoni)*	2	8 - 9
	white sucker *(Catostomus commersoni)*	2	30 - 31
	white sucker *(Catostomus commersoni)*	1	35 - 36

2.4.4.3 Fish Habitat

Bear Brook is approximately four metres wide and 0.6 metres deep, with 0.5 metres high, sandy clay banks, at its mouth. Here the canopy is open with primarily alder-covered banks; only about 10 percent of the bank is undercut. Substrate is composed of 50 percent sand with 40 percent gravel and 10 percent boulder. About 200 metres upstream, immediately below the Highway 104 bridge, cover remains similar but substrate changes to 40 percent silt and sand, 10 percent gravel, 20 percent cobble, 10 percent boulder and 20 percent rock ledge. A significant accumulation of debris, sufficient to restrict upstream passage under low flows, was observed at the upstream side of the Highway 104 bridge. These lower sections of the brook provide poor rearing and no spawning habitat. Electrofishing on May 22, 1992 approximately 200 metres upstream from the mouth indicated that trout were absent from this lower section of Bear Brook.

Five kilometres upstream the Brook passes under the Route 289 bridge. The Westville sewage treatment plant discharges into the Brook 300 metres further upstream. In the 300 metres between the sewage treatment plant and the Route 289 bridge, forest cover near the Brook is largely mixed wood and alder. The east bank is steep and about 10 metres high in the initial 125 metres of the section. Stream substrate ranges from a high proportion of boulder and sand to predominantly gravel. The first 125 metres is primarily a moderately deep run, changing to primarily pool habitat with small riffle areas for the next 175 metres. The latter section has some areas of appropriately-sized gravel for trout spawning, but the sand and silt content is too high for these areas to be considered significant spawning habitat.

Electrofishing over a 50 metres section immediately above the sewage plant discharge found only white sucker. The absence of trout even above the sewage plant discharge suggests that at least the lower main section of Bear Brook no longer provides significant fish habitat.

The next 500 metres of the brook (300 metres to 800 metres upstream of the Route 289 bridge) shows some improvement in trout habitat, but the proportion of silt and sand in the substrate remains relatively high. Banks generally slope gently and about 30 percent are undercut. In some areas, the east bank ranges from 3 metres to 10 metres high and some erosion is occurring. In riffle areas, substrate is generally about 70 percent gravel with cobble and boulder ranging from 5 to 20 percent. Fish habitat is about 70 percent pool with riffles common at bends. Some pockets of possible trout spawning were observed 500 metres and 650 metres upstream of the bridge. Substrate in a small area 500 m upstream of the bridge also could provide pockets of marginal spawning for salmon.

The remaining 800 metres to the CN rail crossing of the brook is primarily muskrat pondage with many small dams. Overall, this section provides marginal trout habitat. Substrate in a small area immediately below the first muskrat dam is approximately 80 percent cobble and could provide some marginal spawning habitat for salmon. Other small areas of riffle and possibly salmonoid spawning habitat exist between dams, but overall quality is poor. None of dams appeared to be barriers to fish migration under normal flow conditions.

2.4.4.4 Existing Habitat Impacts

Currently, Bear Brook only provides significant trout habitat in more headwater areas. In mid-June of 1991, electrofishing by Fisheries & Oceans Canada personnel found adult trout in Bear Brook immediately below the Highway 104 bridge (MacInnis, pers. comm.). In early October of 1991, trout were observed moving upstream through a culvert about 3 kilometres upstream (MacInnis, pers. comm.). The absence of any young trout in the main Brook suggests that trout migrate through the Brook to more headwater areas (e.g., upstream of the main CN rail line crossing).

The absence of young trout in the lower 6.5 kilometres of Bear Brook is likely associated with siltation and poor water quality. Recent levels of ammonia in Bear Brook are presented in Table 2-6. Also data collected by Environment Canada at the Highway 104

bridge immediately downstream of the mouth of Bear Brook has shown elevated levels of ammonia on at least one occasion in 1990 and again in 1991 during low summer flows. Ammonia is highly toxic to fish, particularly brook trout. It seems reasonable to conclude that discharge from the Westville sewage treatment plant on Bear Brook is at least one source of this ammonia. Mercury, copper, aluminum and iron have also occasionally exceeded guidelines for the protection of freshwater life (Environment Canada water quality data, 1990-1991). In addition, siltation from operations at the Pioneer Mine in Westville and at the Wimpey pit in the 1970's may have further reduced the habitat quality.

Bear Brook is unlikely to be important for reproduction or rearing of Atlantic salmon because of the limited amount of margin salmon habitat available, the water quality and siltation impacts on the Brook, and the relatively low numbers of salmon present in the Middle River. The potential quality of salmon habitat in Bear Brook is sufficiently poor that salmon likely would only use this stream if the population of the Middle River was near its carrying capacity.

2.5 Hydrogeologic Setting

2.5.1 Regional Hydrogeology

Within Pictou County the main formations of hydrogeological interest are the Riversdale, Cumberland, Pictou Groups and Stellarton Series of Carboniterous age. Figure 2-12 presents the stratigraphic relations of these bedrock deposits. The surficial deposits which cover the majority of Pictou County are tills of Quaternary age. These tills, as described in Section 2.2.2. tend to be fine grained and consequently, are not considered significant as a source of groundwater (Cross and Woodlock; 1975).

Gibb and McMullin (1980) analyzed pump test data and individual well test data for the various formations found in Pictou County. Table 2-11 presents a summary of the yields of wells screened in the main hydrostratigraphic units. These data indicate that wells in the Pictou Group and the Riversdale Group have a considerably higher yield than wells located in the Stellarton Series and Cumberland Group.

STRATIGRAPHIC COLUMN

Period	Group	Formation	Lithology
Recent	– – – –	– – – – –	Stream gravels, residual soils, modified glacial gravels
Pleistocene	– – – –	– – – – –	Till; stratified and unstratified sand and gravel
Pennsylvanian	Pictou (2,250m)		Red and grey sandstone, siltstone; red pebble conglomerate; minor shale
	Stellarton (series) (2,860m)		Grey and black coal shale; red and grey sandstone; conglomerate
	Disconformity		
	Cumberland (580m.)	New Glasgow Conglomerate	Greyish red pebble to cobble conglomerate; sandstone and siltstone
	Disconformity		
	Riversdale (2715m.)	Boss Point	Grey and red sandstone; pebble conglomerate; minor limestone pebble conglomerate
		Millsville Conglomerate	Reddish to brown pebble to boulder conglomerate; minor sandstone, siltstone
Mississippian	Canso (850m.)		Grey and red-brown siltstone; argillite and minor sandstone, claystone; limestone; and limestone pebble conglomerate
	Disconformity ?		
	Windsor (580m.)		Shale; calcareous shale; grey limestone; gypsum, anhydrite; conglomerate
	Disconformity		
	Horton (2040m.)		Grey arenite, grey siltstone, shale; and conglomerate
	River John (1830m.)		Pebble to boulder conglomerate; siltstone, and sandstone
Devonian			Siltstone, sandstone; minor shale, pebble conglomerate, limestone conglomerate; oil shale; felsite; breccia

	Unconformity (?)		
Devonian (cont.)	– – – –	– – – – –	Dark green, fine to medium grained diabase
	– – – –	– – – – –	Grey biotite and muscovite granite; minor syenite; pink and green granite
	Cobequid Complex		Granodiorite, minor syenite, granite, meta-sedimentary rocks, andesite, minor felsite and tuff
		Knoydart (305m)	Red sandy slate; grey sandstone
	Arisaig (1070m.)	Stonehouse	Blue-grey calcareous and argillaceous sandstones and siltstones
Silurian		Moydart	Grey mudstone; sandstone, siltstone, minor limestone; red calcareous mudstone
		McAdam	Grey shale, bluegrey siltstone, sandstone and calcareous siltstone
		French River	Blue-grey sandstone; blue-grey and green-grey muddy sandstone
		Ross Brook	Grey mudstone and shale; blue-green quartz sandstone and siltstone
		Beechhill Cove	Green and blue-grey sandstone and siltstone
Ordovician	— — —	— — —	Hornblende granite and quartz feldspar granodiorite
Cambro-Ordovician	— — —	— — —	Gabbro, medium grained hornblende diorite
	Brown's Mountain (760m+)	Brierly Brook	Dark green andesite, tuff, breccia, sandstone, argillite and dacite
		Baxter Brook	Red and grey sandstone and slate, schist
		Keppoch	Leuco-dacite tarhyolite; breccia and tuff; minor grey quartzite and phyllite

NOLAN, DAVIS & ASSOCIATES

FIGURE 2-12
STRATIGRAPHIC COLUMN

JUNE 1992

H92561

TABLE 2-11

Analysis of Yields in Various Hydrostratigraphic Units in Pictou County.

Hydrostratigraphic Unit	Mean m^3/min	Standard Deviation	Range m^3/min.	Number of Wells
Pictou Group	0.17	0.28	0.0045-2.73	86
Stellarton Series	0.059	0.13	0.0045-0.46	44
Cumberland Group	0.064	0.12	0.0045-0.45	25
Riversdale Group	0.20	0.032	0.0045-2.39	33

Note: Specific capacities (pumping rate divided by total drawdown) were calculated and multiplied by 30. Yield are expressed per 30m of saturated thickness.
(adapted from Gibb and McMullin (1980))

Cross and Woodlock (1975) and Gibb and McMullin (1980) indicate that the source of the groundwater from these formations is primarily due to secondary permeability (fractures) which predominantly occurs along bedding planes, fault planes and joints. From these studies there is no indication of the degree of interconnection between these major hydrostratigraphic units.

Gibb and McMullin (1980) also conducted a groundwater sampling program in their study which was designed to determine natural groundwater quality in each of the hydrostratigraphic units. Table 2-12 presents the mean concentrations of the groundwater constituents analyzed in their study. Groundwater quality is typically best in the Cumberland Group and poorest in the Stellarton Series. The Gibb and McMullin (1980) sampling program indicated that all four hydrostratigraphic units had exceedances of the Canadian Drinking Water Quality Guidelines (GDWQG, 1989) for iron and manganese except in the Cumberland Group where all chemical constituents were within the Guidelines.

TABLE 2-12
Mean Concentrations
Of Groundwater Quality Data

HYDROSTRATIGRAPHIC UNIT	Sodium	Potassium	Calcium	Magnesium	Ca CO_3 (Hardness)	Ca CO_3 (Alkalinity)	Sulphate	Chloride	Fluoride	Silica	Nitrate + Nitrite (as N)	Ammonium (as N)	Arsenic	Iron	Manganese	Copper	Zinc	Lead	Total Phosphate	Suspended Solids	Total Dissolved Solids	Colour T C U	Turbidity J T U	Conductivity Us/cm	pH (Lab)
Pictou Group (19 samples)	25.9	3.0	37.6	8.3	129	140	18.5	21.0	0.30	10.1	0.28	0.1	0.005	0.26	0.27	0.05	0.12	0.01	0.06	9.5	222	13	7.1	311	7.3
Stellarton Series (14 samples)	153.9	7.4	35.9	8.3	130	280	32.4	96.5	0.36	7.1	7.84	0.39		3.2	0.27	0.05	0.02	0.02	0.05	18.5	581	16.3	49	611	7.8
Cumberland Group (7 samples)	89.9	1.9	24.8	1.1	77.2	187	37.6	40.5	0.63	6.7	0.13	0.1	0.005	0.17	0.02	0.04	0.10	0.01	0.10	57.8	360	27	10.5	497	8.2
Riversdale Group (14 samples)	57.1	2.9	33.4	4.6	103	108	18.1	100	0.03	8.3	2.35	0.19	0.005	0.4	0.08	0.17	0.12	0.01	0.04	50.7	301.6	27.1	17.8	421	8.1

Adapted From Gibb And McMullin (1980)

The water quality of wells located in the Stellarton Series is often of lesser quality than those in the Pictou Group which is likely the result of influence by the coal formations and abandoned coal mines. Fifty percent of the samples collected by Gibb and McMullin (1980) from the Stellarton Series had concentrations of iron and manganese above the Canadian recommended acceptable limits. Twenty-five percent exceed the standard for chloride. These samples also generally exhibited high levels of colour and turbidity.

Gibb and McMullin (1980) conclude that for Pictou County, the Pictou Group and Riversdale Group aquifers have the most potential to provide the large quantities of groundwater necessary for major industrial or municipal users. They also indicate that the Cumberland Group and the Stellarton Series have the potential for use as water supplies to individual homes and other small to medium volume users. However, they note that the Stellarton Series aquifer maybe of limited use because of its relatively poor water quality.

Within the Pictou Basin, one would expect the regional groundwater flow to migrate down-dip towards the northeast and also for the shale units to act as very effective aquitards, especially at depth. However, the numerous major structural features surrounding and within the Basin will have a substantial impact on the groundwater flow systems. It is likely that such features will serve as conduits for groundwater recharge and discharge which will tend to "short-circuit" movement along bedding planes.

McLellans Mountain to the southeast, the Cobequid Mountains to the west, and the upland area to the south, are the most likely sources of recharge to the deep flow systems. This recharge probably takes thousands of years to reach the deeper flow systems within the Basin. Most regional discharge within the study area will be directed towards Pictou Harbour while the Middle and East Pictou Rivers will also serve as important discharge points.

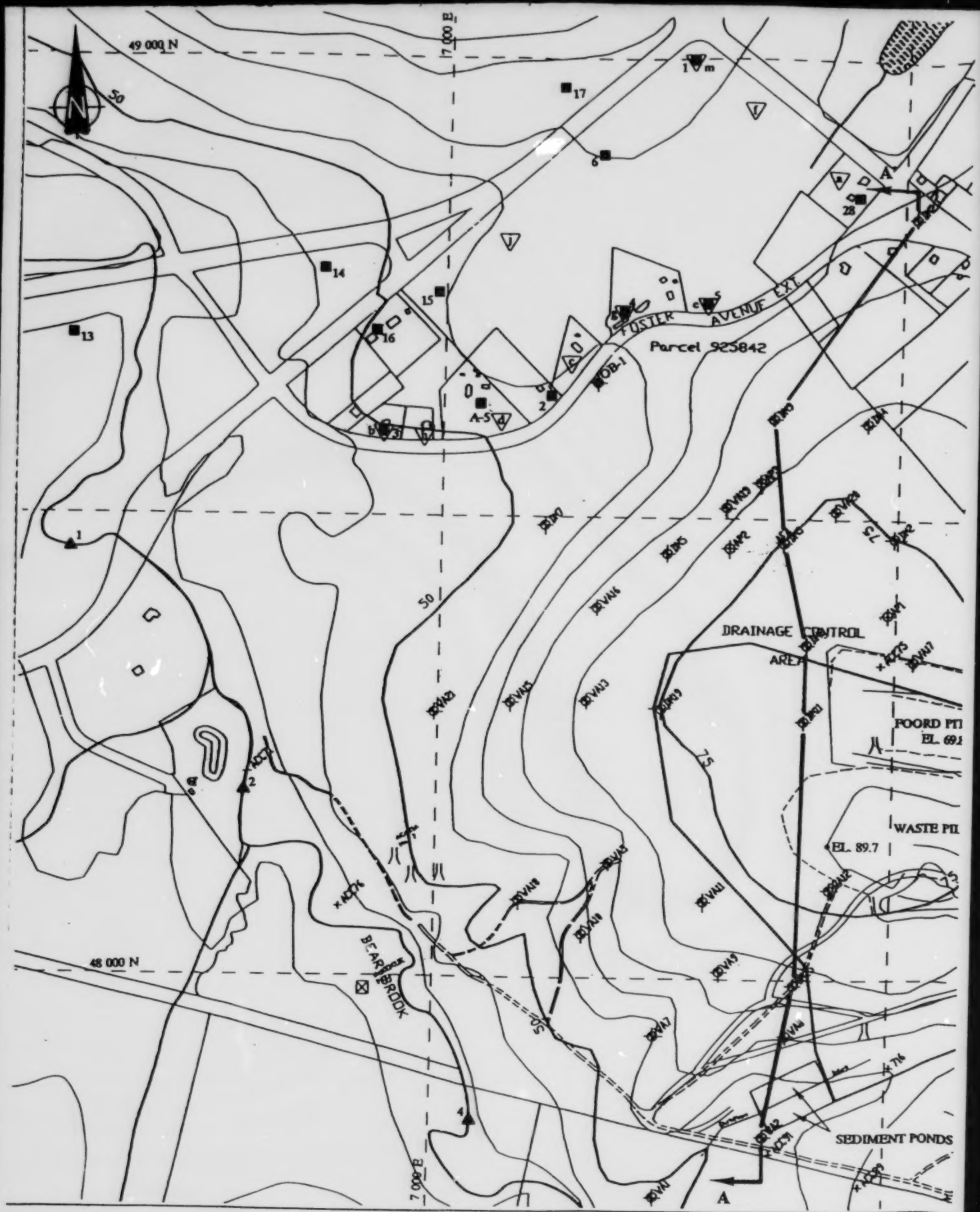
2.5.2 Site Hydrogeology

Figure 2-13 shows the location of local wells and boreholes in the vicinity of the site. Over the past two decades, several hydrogeological studies have been conducted on the site or on properties in the immediate vicinity of the site. In conjunction with data collected in 1992, the following reports have been the primary sources of information for the development of this assessment of the site hydrogeology: Cross and Woodlock (1975), Wimpey (1977), Gibb and McMullin (1980); Hydrogeo Canada (1981), and Nolan, Davis (1986, 1990).

The site is located within the Northeastern Appalachian Hydrogeological Region of North America (Heath, 1988) and is characterized by hilly terrain underlain by glacial deposits over a mixture of sedimentary and metamorphic rock complexly intruded by igneous rocks. This section describes the two primary hydrostratigraphic units found at the site and their physical and chemical characteristics. The description assumes the validity of the Darcy continuum and therefore, includes a macroscale interpretation.

2.5.2.1 Overburden - Till Hydrostratigraphic Unit

This hydrostratigraphic unit is comprised of the glacial till which has been described in detail in Section 2.2. As previously discussed, this unit is not considered of significance as an aquifer (Gibb and McMullin, 1980). This is due to its low primary permeability which has been estimated to range between 10^{-6} and 10^{-8} centimetres per second (cm/sec) (Nolan, Davis; 1986). Regional testing of this till does not indicate any significant secondary permeability. To date, no on-site testing of this unit has been conducted; however, 3.5 kilometres to the southeast, at the Westray Plymouth site, four piezometers have been installed in this unit. As well, samples of the till were collected and grain-size analyses were performed. Based on the regional and local mapping of this till unit, it is felt that the data from the Plymouth site would be representative of the till found on this site.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48 000 N
17 000 E
18 000 E
FOSTER AVENUE EXT.
Parcel 925842
OB-1
DRAINAGE CONTROL
AREA
POORD PIT
EL. 69.2
WASTE PIT
EL. 89.7
BEAR BROOK
SEDIMENT PONDS
50
75

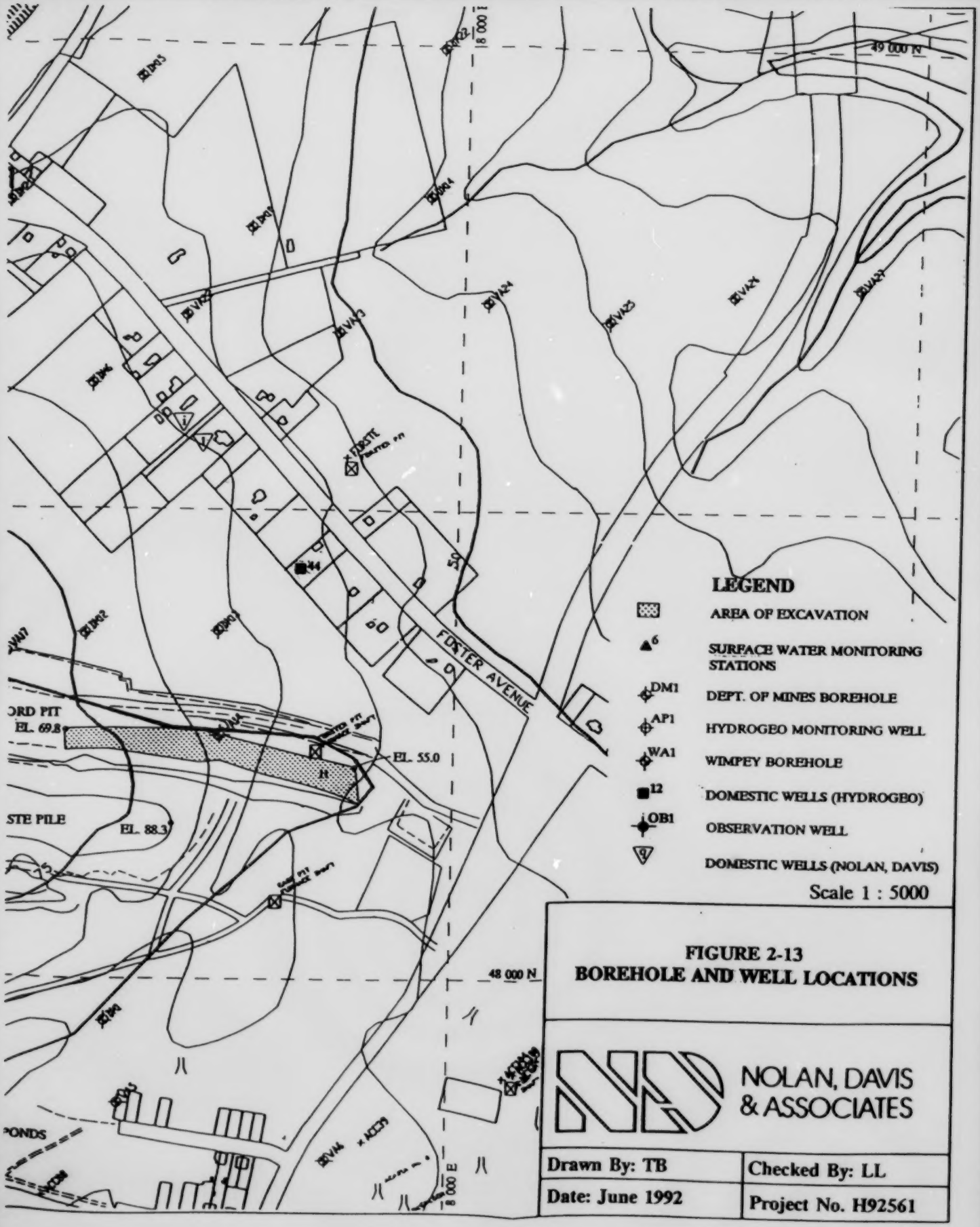


FIGURE 2-13
BOREHOLE AND WELL LOCATIONS

NOLAN, DAVIS & ASSOCIATES

Drawn By: TB	Checked By: LL
Date: June 1992	Project No. H92561

Hydraulic conductivity values derived for this unit from falling-head (slug) tests are presented in Table 2-13. Considering the above information, this unit is classified as an aquitard which is best described in macro context as a homogeneous, anisotrophic (due to reported sand seams (JWA, 1986; Nolan, Davis, 1986)), non-fractured, semi-consolidated media, with relatively high matrix porosity. The vertical gradients generally exceeded the lateral gradients (Nolan, Davis; 1990); consequently the predominant direction of groundwater movement in this hydrostratigraphic unit would be downward.

Nolan, Davis (1990) collected water samples from the five piezometers located in this unit. A summary of the five water chemical analyses obtained from this unit is provided in Table 2-14 and plotted on a trilinear diagram in Figure 2-14. These analytical results indicate that the groundwaters in this unit may be characterized as a fresh, very hard and predominately sodium/calcium-bicarbonate type water. In general the water quality is good with only iron and manganese exhibiting concentrations above the maximum acceptable concentrations (CDWQG, 1989). No spatial trends were noted in the data, which exhibits a greater similarity between samples, than do samples from wells located in the Stellarton Series.

2.5.2.2 Bedrock - Stellarton Series Hydrostratigraphic Unit

Hydraulic Characteristics

This hydrostratigraphic unit is comprised of the geological facies of the Stellarton Series which specifically on-site encompass the inter-bedded units lying between the Third and the Foord Seams (Cross-section A-A'; Figure 2-15). In addition to the regional information published by Gibb and McMullin (1980), Hydrogeo (1981) installed pumping and observation wells on the site and performed in-situ hydraulic testing of this hydrostratigraphic unit. These tests included a long-term (four month) pump test to assist in determining the effects of dewatering the Foord coal formation.

TABLE 2-13

Hydraulic Conductivity for Hydrostratigraphic Units from Piezometers on the Plymouth Site

Stellarton HU	K (cm/sec)
1A	7.3E-06
1B	5.1E-06
2A	1.3E-05
3A	1.3E-05
3B	1.0E-05
4A	3.2E-06
4B	5.5E-06
5A	1.2E-05
5B	5.8E-06
Till HU	
1C	4.6E-07
2B	7.8E-06
4C	2.5E-06
5C	1.0E-06

Data derived from slug testing through piezometers interpretation using Hvorslev Method

Adapted from Nolan, Davis (1990)

TABLE 2-14

Westray Groundwater Chemistry Data

	PN 6A	PN 6A **	PN 6B**	PN 6C	PN6C **	PN 7A	PN 7A**	PN 7B	PN 7B**	PN 7C
SODIUM	198			21.2		96		67.3		147
POTASSIUM	7.4			2		6.2		1.1		3.9
CALCIUM	1	4.28	15.5	64	64.1	2	15.2	327	28	2
MAGNESIUM	26	1.55	3.68	9.5	8.5	1.9	6.22	6.3	5.63	1.4
HARDNESS	13.2	17.1	53.8	199	195	12.8	63.6	108	93.1	10.8
ALKALINITY	380			210		150		240		290
CARBONATE (CaCO3)	326			1.96		10.4		223		20.1
BICARBONATE (CaCO3)	347			208		139		238		269
SULFATE	<2			28		15		3		6
CHLORIDE	33			15.8		41		10.4		25
SILICA REACTIVE	6.9			9.7		7.9		7.8		6.4
ORTHO PHOSPHOROUS as P	0.04			<0.01		<0.01		<0.01		<0.01
NITRATE NITRITE as N	<0.05			<0.05		0.06		<0.05		<0.05
AMMONIA as N	0.23			<0.05		0.2		<0.05		0.23
T.O.C.	1.5			29		4.4		0.5		2
LANGLIER INDEX @ 5 C	-0.3			0.3		-.5		0.1		-0.2
ION SUM	477			276		261		273		366
COLOR TCU	450			6		>1000		4		>1000
TURBIDITY NTU	276			0.43		>1000		217		656
CONDUCTIVITY umhos/cm	810			520		440		480		630
LAB PH	9			8		8.9		8		8.9
IRON	1.58	6.46	8.24	<0.02	1.02	9.4	42	0.07	1.7	4.15
MANGANESE	0.04	0.07	0.4	1.52	1.63	0.21	0.33	0.36	0.4	0.08
COPPER	<0.01	0.06	0.14	<0.01	0.05	0.02	0.24	<0.01	0.08	0.01
ZINC	0.02	0.03	0.1	0.01	0.01	0.13	0.18	<0.01	0.02	0.05
ALUMINUM		3.29	5.45		0.78		16.7		0.85	
BORON		0.18	<0.1		<0.1		0.12		0.1	
BARIUM		0.214	0.374		0.208		1.36		0.689	
BERYLLIUM		<0.005	<0.005		<0.005		<0.005		<0.005	
CHROMIUM		<0.02	<0.02		<0.02		0.03		<0.02	
COBALT		<0.05	<0.05		<0.05		<0.05		<0.05	
NICKEL		<0.02	0.02		<0.02		0.05		<0.02	
ANTIMONY		<0.05	<0.05		<0.05		<0.05		<0.05	
SELENIUM, Plasma		<0.1	<0.1		<0.1		<0.1		<0.1	
TIN		<0.05	<0.05		<0.05		<0.05		<0.05	
VANADIUM		<0.01	0.02		<0.01		0.05		<0.01	
LEAD, Plasma		<0.05	<0.05		<0.05		<0.05		<0.05	
CADMIUM, Plasma		<0.01	<0.01		<0.01		<0.01		<0.01	

NB: All samples collected on August 8, 1991

** samples filtered and acidified on the field

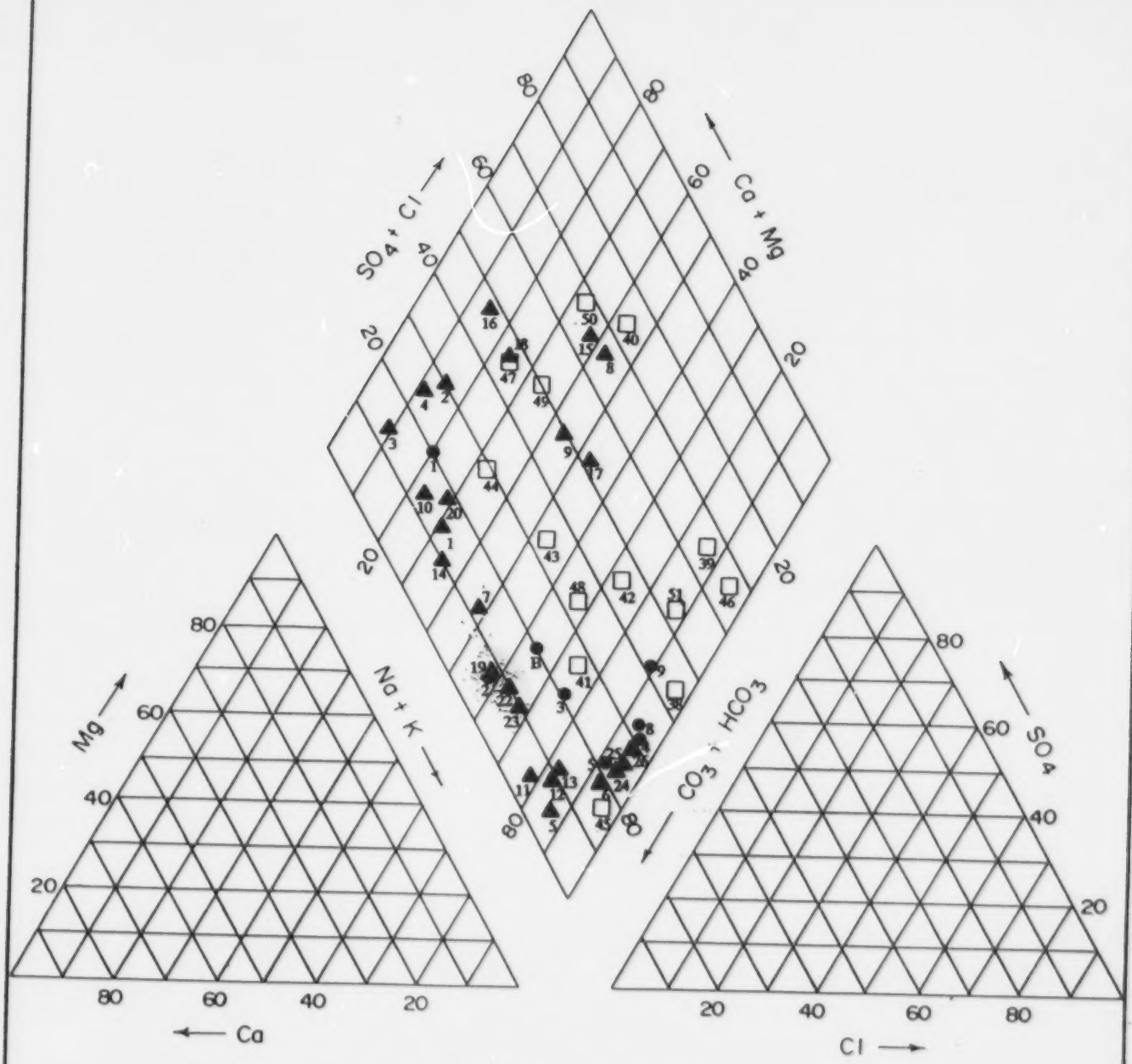
TABLE 2-14

Westray Groundwater Chemistry Data

	PN 8A	PN 8A **	PN 8B	PN 8B **	PN 8C **	PN 9A	PN 9A **	PN 9B	PN 9B **
SODIUM	146		76.5			62.6		120	
POTASSIUM	8.2		24			26		8.2	
CALCIUM	1.3	13	14.5	15.3	23.2	5.3	21.7	7.9	17.6
MAGNESIUM	24	6.12	3.8	4.28	4.84	1.1	7.5	1.9	5.24
HARDNESS	13.1	57.6	51.8	55.8	77.8	17.8	84.9	27.5	65.5
ALKALINITY	230		180			90		220	
CARBONATE (CaCO3)	16		4.15			3.24		5.07	
BICARBONATE (CaCO3)	214		1767			86.6		215	
SULFATE	<2		27			6		<2	
CHLORIDE	73		16.4			40		42.2	
SILICA REACTIVE	9.2		6.8			4.1		10.1	
ORTHO PHOSPHOROUS as P	0.01		<0.01			<0.01		<0.01	
NITRATE NITRITE as N	<0.05		<0.05			0.09		0.05	
AMMONIA as N	0.18		0.35			0.19		0.72	
T.O.C.	29		1.4			4.3		5.8	
LANGLIER INDEX @ 5 C	-0.5		0			-0.6		-0.2	
ION SUM	378		256			176		323	
COLOR TCU	>1000		63			1000		1000	
TURBIDITY NTU	>1000		31.2			1000		910	
CONDUCTIVITY umhos/cm	640		430			306		570	
LAB PH	8.9		8.4			8.6		8.4	
IRON	12.5	45.2	0.44	6.04	2.85	7.95	57.7	5.3	28.9
MANGANESE	0.27	0.29	0.13	0.3	0.32	0.27	0.76	0.21	0.56
COPPER	0.02	0.24	<0.01	0.07	0.16	0.02	0.16	0.04	0.13
ZINC	0.14	0.15	0.02	0.06	0.03	0.14	0.33	0.09	0.16
ALUMINUM		17.9		3.19	1.81		19.8		10.9
BORON		0.13		0.12	<0.1		0.12		0.12
BARIUM		1.6		0.685	0.197		1.68		0.897
BERYLLIUM		<0.005		<0.005	<0.005		0.06		<0.005
CHROMIUM		0.04		<0.02	<0.02		0.03		<0.02
COBALT		<0.05		<0.05	<0.05		<0.05		<0.05
NICKEL		0.04		<0.02	<0.02		0.05		0.04
ANTIMONY		<0.05		<0.05	<0.05		<0.05		<0.05
SELENIUM, Plasma		<0.1		<0.1	<0.1		<0.1		<0.1
TIN		<0.05		<0.05	<0.05		<0.05		<0.05
VANADIUM		0.05		<0.1	<0.01		0.06		0.03
LEAD, Plasma		<0.05		<0.05	<0.05		<0.05		<0.05
CADMIUM, Plasma		<0.01		<0.01	<0.01		<0.01		<0.01

NB: All samples collected on August 8, 1991

** samples filtered and acidified on the field



PER CENT OF TOTAL EQUIVALENTS PER MILLION

LEGEND

- □ Gibb & McMullin (1980)
- ▲ Hydrogeo Data (1981)
- ● Nolan, Davis (1991)

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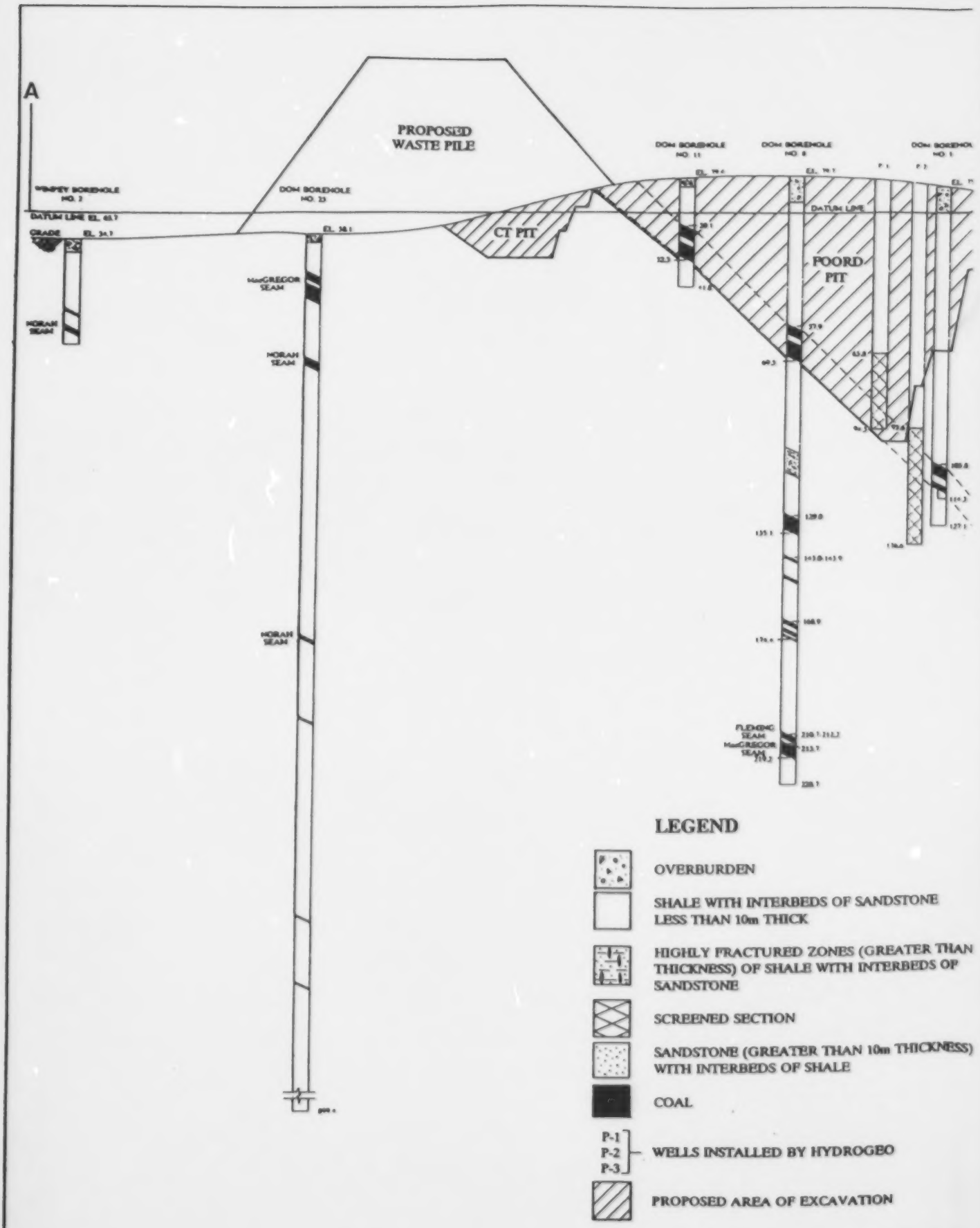
FIGURE 2-14
TRI-LINEAR DIAGRAM
WESTRAY COAL INC.
PICTOU COUNTY, NOVA SCOTIA

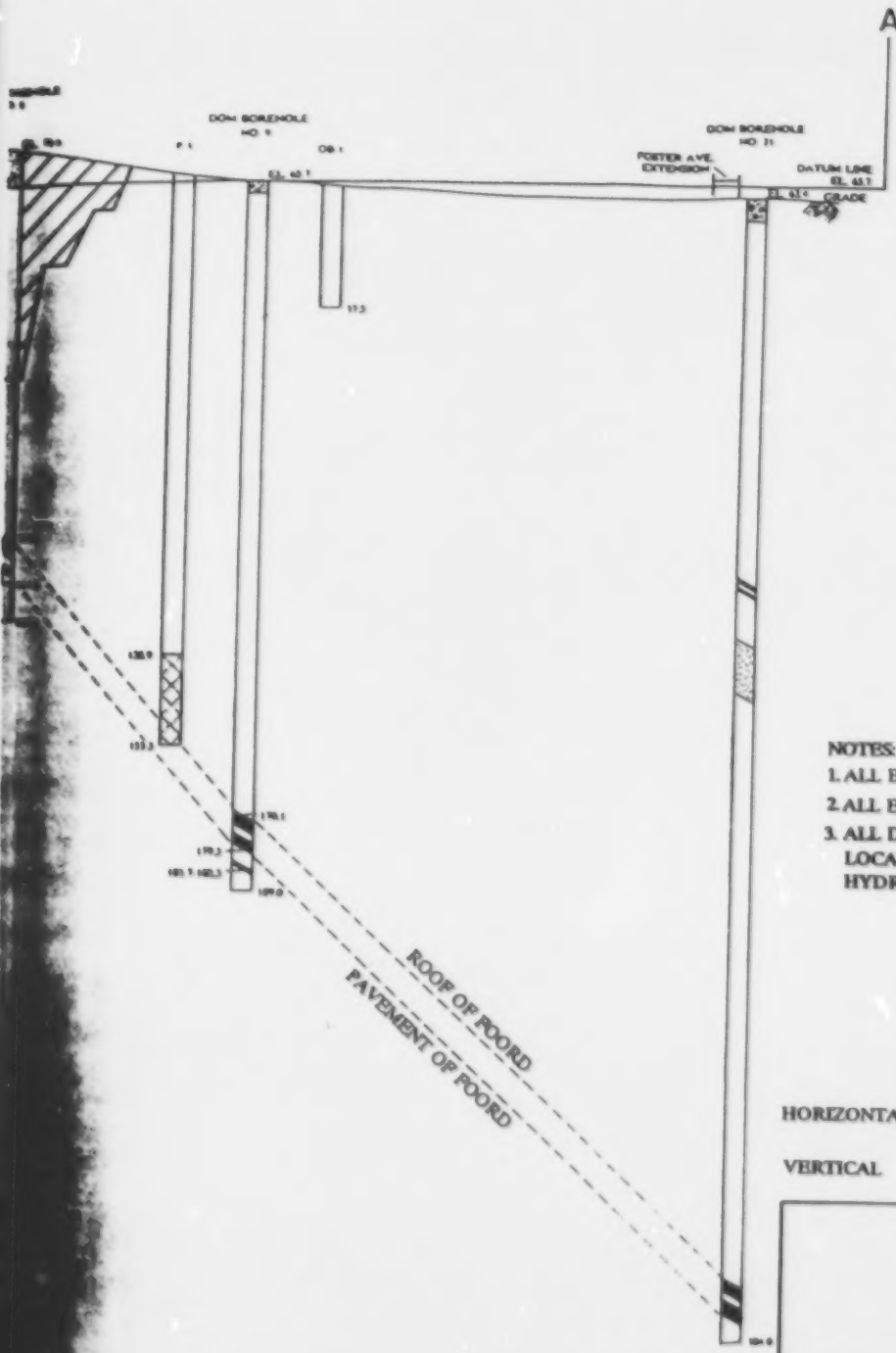
JUNE 1992

H92561



LEGEND

- OVERBURDEN
- SHALE WITH INTERBEDS OF SANDSTONE LESS THAN 10m THICK
- HIGHLY FRACTURED ZONES (GREATER THAN THICKNESS) OF SHALE WITH INTERBEDS OF SANDSTONE
- SCREENED SECTION
- SANDSTONE (GREATER THAN 10m THICKNESS) WITH INTERBEDS OF SHALE
- COAL
- P-1, P-2, P-3 — WELLS INSTALLED BY HYDROGEO
- PROPOSED AREA OF EXCAVATION



NOTES:

1. ALL BEDROCK DIPPING AT ~ 25°
2. ALL ELEVATIONS AND DEPTHS ARE IN METERS (m).
3. ALL DRILLHOLES AND WELLS ARE LOCATED IN THE STELLARTON GROUP HYDROSTATIGRAPHIC UNIT

SCALE

HORIZONTAL 0 80 160(m)

VERTICAL 0 40 80(m)

FIGURE 2-15
CROSS SECTION A-A'

NOLAN, DAVIS & ASSOCIATES

Drawn By: TB	Checked By: LL
Date: June 1992	Project No. H92561

REFERENCE:
PROVINCE OF NOVA SCOTIA DEPARTMENT OF MINES, COAL INVENTORY SURVEY, DATED 1974.

As previously discussed, Gibb and McMullin (1980) analyzed data from forty-four domestic wells located in the Stellarton Group. These data gave a mean yield of approximately one litre per second. The data collected by Hydrogeo (Table 2-15) provides hydraulic data on the Stellarton Group at greater depths. These data were collected from wells drilled to depths from 94.5 to 352.5 metres and cased to depths of 65.8 to 276.8 metres. The hydraulic conductivity values ranged from 8.2×10^{-7} to 2.4×10^{-3} cm/s. In general, the upper portion of this unit at the site exhibits high hydraulic conductivity values.

During the hydrogeological site assessment of the Westray Plymouth site, couplet piezometers were installed at five locations up to 16 metres below subcrop in the Stellarton Series. The results of falling head tests on these piezometer are summarized in Table 2-13. The calculated hydraulic conductivity values range from 3.2×10^{-6} to 1.3×10^{-5} cm/s, which is consistent with data previously collected on this unit.

To date there is no in-situ information available on the K_v to K_h ratio or the matrix or fracture porosity or effective porosity. Values have been derived from the literature for K_v:K_m porosity ratio, and are assumed to be in the range of 0.05 to 0.15.

Based on the above information, this hydrostratigraphic unit can best be described as a relatively homogeneous, anisotropic, fractured, consolidated media which exhibits low primary porosity. Flow will be fracture controlled, with fractures characterized as open, orthogonal, discontinuous and poorly interconnected in some areas in three dimensions. However, with the broad range in hydraulic conductivities measured at the site it would appear that mining and other man-induced influences have resulted in increased hydraulic conductivity in some areas.

Groundwater Flow Directions

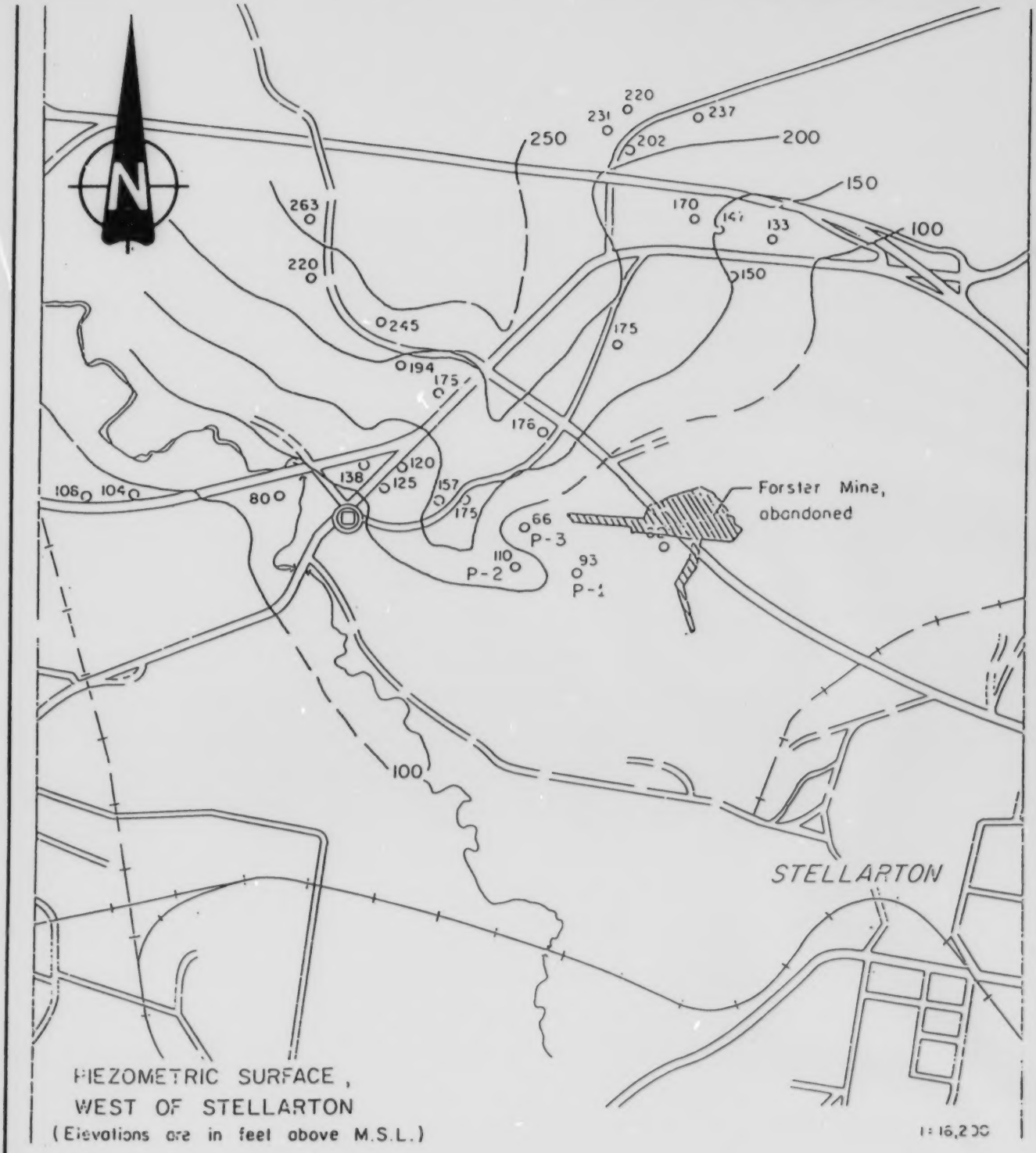
Based upon the work conducted on-site by Hydrogeo (1981), groundwater flow in this unit does not appear to follow regional flow directions. Their hydraulic head data (Figure 2-16) indicate a localized hydraulic sink in the vicinity of the old Forster Pit which

TABLE 2-15

Stellarton Group
Deep Hydrogeologic Test Results

Parameter	Method	Well No. P1	P2	P3	81-P4	81-P5	81-P6
Well Depth (m)		94.5	136.6	153.3	316.5	304.7	352.5
Casing Depth (m)		65.8	93.6	128.9	187.6	169.6	276.8
T (m^2/s)	Drawdown	2.9×10^{-4}		1.0×10^{-4}			
	Recovery	8.7×10^{-5}	3.2×10^{-4}	1.0×10^{-4}	5.8×10^{-7}	1.4×10^{-7}	1.1×10^{-6}
			2.3×10^{-5}				
S		3.4×10^{-5}	3.3×10^{-4}	-	-	-	-
Discharge (L/s)		6.1	6.1	6.1	0.2	0.2	0.2
Hydraulic Conductivity (cm/s)							
Aquifer Test (T Value)					4.5×10^{-9}	3.6×10^{-9}	1.5×10^{-8}
Slug Test	Rising				1.6×10^{-6}	1.2×10^{-6}	-
	Falling	2.7×10^{-4}	2.9×10^{-5}	2.4×10^{-3}	3.1×10^{-6}	8.2×10^{-7}	-
Recovery		2.8×10^{-4}	2.9×10^{-5}	1.6×10^{-3}	10^{-6}-10^{-7}	10^{-6}-10^{-7}	10^{-6}-10^{-7}
Reference		Hydrogeo, 1980's	Hydrogeo, 1980 a,b	Hydrogeo, 1980a	Noval, 1982	Noval, 1982	Noval, 1982

Note: P3 pumping well in 1980 aquifer test, P1 and P2 observation wells
T values for P4, P5, and P6 measures a discharge of 0.2 L/s
K value recovery test is a "blow" test using a drill rig to dewater the borehole
Adapted from Hydrogeo (1981)



Adapted from Hydrogeo Canada Inc.
(circa 1981 Fig.4)

NOLAN, DAVIS & ASSOCIATES

FIGURE 2-16
PIEZOMETRIC SURFACE FROM HYDROGEO (1981)

JUNE 1992

H92561

is located within the Foord Seam. Hydrogeo (1981) in their analysis of the hydraulics of this hydrostratigraphic unit conclude that the previous mining of the Foord Seam, both commercial and bootleg, have had significant effects on both localized hydraulic conductivity values, flow directions and recharge to this unit.

A considerable amount of water quality data has been collected over the past fifteen years on the Stellarton Series hydrostratigraphic unit. These data include groundwater samples from the site or the immediate vicinity of the site collected by Wimpey in 1977, Hydrogeo in 1980 and Nolan, Davis in 1992. Nolan, Davis also has detailed chemical analysis of groundwater from the Plymouth site in 1991. All these data are included in Appendix 2.

During 1992, Nolan, Davis determined which residences in the immediate vicinity of the site still used groundwater wells as a source of water. These residences are shown in Figure 2-13. A survey of all these residences was conducted to obtain all pertinent information available on these wells. Although little formal documentation is available, it appears that all the wells are located in bedrock. These wells were sampled and a limited list of constituents were analyzed. Data is presented in Table 2-16.

The documented Wimpey groundwater chemical quality data cannot be confidently compared to the existing 1992 data. The 1992 were collected from domestic wells adjacent to the site, whereas, Wimpey data indicates sample locations from outlets of old mine workings and standpipes installed on site (since destroyed) which appear not to have been properly purged and developed.

Figure 2-14 presents a tri-linear diagram of the Gibb and McMullin (1980) regional data for the Stellarton Series, the data from the Hydrogeo study conducted on the site and the data collected from the Plymouth site by Nolan, Davis. Of the domestic wells sampled in 1980 by Hydrogeo, four of these wells were sampled again by Nolan, Davis in 1992. Table 2-17 presents a comparison of these data. As can be seen from Figure 2-12

TABLE 2-16
GROUNDWATER CHEMISTRY

Water Well Sampling
January 16, 17, 20, 1992

PARAMETER	UNITS	a	b	c	d	e	f	g	h	i	j	k	l	m	Guidelines For Canadian Drinking Water Quality (1989)
Sodium	mg/L	79.2	32.6	86.2	14.2	76.9	24.3	70.5	11.5	107	18.5	207	132	114	< 200 (aesthetic)
Potassium	mg/L	3	3.6	3.2	1.4	2.2	2.3	1.7	1.4	5.3	2.7	2.3	3.4	5	
Calcium	mg/L	55	50	23.3	19.7	14.3	38.9	16.2	19.7	50.5	49.3	0.2	36.1	129	
Magnesium	mg/L	8	9.4	6.4	3.4	4.2	4.9	4	3.5	14.2	8.2	<0.1	11.4	18.3	
Alkalinity	mg/L	240	170	240	39	130	120	130	46	320	170	330	360	140	
Sulfate	mg/L	14	13	15	9	6	11	32	10	80	13	14	41	28	< 500 (aesthetic)
Chloride	mg/L	58.4	35.8	16.5	31.6	55.7	30.1	26.7	25.3	6.2	16	80.5	6.6	330	< 250 (aesthetic)
Silica	mg/L	13.6	13.9	10	8.7	13.3	17.6	12.1	9.3	6.6	14.8	15.6	10.1	13.1	
Ortho Phosphate	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Nitrate + Nitrite	mg/L	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	0.38	0.24	0.6	<0.05	<0.05	2.1	0.09	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	0.96	1.3	1.9	<0.05	0.97	0.56	0.16	<0.05	2.3	0.6	1.62	<0.05	0.72	
Iron	mg/L	2.27	0.06	0.02	0.3	2.74	3.7	0.09	0.03	<0.02	0.05	<0.02	<0.02	1.23	< 0.3 (aesthetic)
Manganese	mg/L	0.71	0.29	0.03	<0.01	0.36	0.87	0.03	<0.01	0.05	0.31	<0.01	<0.01	1.39	
Copper	mg/L	<0.01	<0.01	<0.01	0.23	<0.01	<0.01	<0.01	1.4	0.02	<0.01	<0.01	0.02	<0.01	< 0.05 (aesthetic)
Zinc	mg/L	0.03	0.02	<0.01	0.04	<0.01	0.01	0.01	0.15	1.88	0.01	<0.01	0.03	0.18	< 1.0 (aesthetic)
Colour	TCU							<3	<3	<3	<3	<3	<3	30	< 5.0 (aesthetic)
Turbidity	NTU	28.5	4.45	4.18	4.48	29.2	43	1.99	0.17	0.39	0.83	0.28	0.43	16.6	< 15 (aesthetic)
Spec. conduct.	umhos/c	683	496	529	210	469	359	432	201	814	415	948	777	1430	< 5 (if no disinfection)
pH	Units	7.5	7.4	7.9	6.5	7	7	7.6	6.3	7.5	7.5	7.7	7.5	7.1	6.5-8.5
Tot Organic Carbon	mg/L	0.8	1.4	1	1	1	1.1	0.6	0.7	1.5	1.8	1	0.9	1	
Hardness	mg/L	170	164	84.5	63.2	53	117	56.9	63.6	185	156	0.5	137	397	
Bicarbonate	mg/L	239	170	238	39	130	120	129	46	319	169	328	359	140	
Carbonate	mg/L	0.71	0.4	1.78	0.01	0.12	0.11	0.48	0.01	0.93	0.5	1.55	1.07	0.17	
Ion Sum	mg/L	376	262	307	112	252	202	243	109	467	223	520	466	723	
Theor. Conduct.	umhos/c	709	494	553	213	468	365	434	203	854	406	937	828	1530	
Cation Sum	mg/L	6.99	4.87	5.66	1.92	4.53	3.5	4.26	1.81	8.64	4.04	9.19	8.57	13.1	
Anion Sum	mg/L	6.74	4.68	5.58	1.86	4.3	3.48	4.05	1.86	8.28	4.08	9.16	8.39	12.7	
% Difference	%	1.86	2.01	0.71	1.37	2.66	0.33	2.57	1.39	2.14	0.47	0.15	1.06	1.5	
Langelier Index		-0.24	-0.52	0.2	-2.44	-1.58	-1.17	-0.92	-2.56	-0.16	-0.42	-2.35	-0.25	-0.53	
Saturation pH	UNITS	7.74	7.92	8.1	8.94	8.58	8.17	8.52	8.86	7.66	7.92	10.1	7.75	7.63	

Note:

a:identifier to be cross referenced to Figure 4 and Groundwater Characterization sheet
A. Moulton - Residence/Homeowner
Aesthetic: those aspects of water that are perceivable by the senses
859025 - Land Registry and Information Service Number

mg/L = milligrams per litre (equivalent to parts per million)
TCU = True Colour Units
NTU = Nephelometric Turbidity Units
umhos/c = micromhos per centimetre

and Table 2-17, overall these data are comparable, with the exception that many of the wells sampled by Hydrogeo appear to have water quality more comparable to the chemical signature presented by Gibb and McMullin (1980) for waters from the Pictou Group (Figure 2-17). Reviewing the cross-sections presented in Figure 2-15 and considering the depths of most of these domestic well are between 30 and 60 m, this would seem reasonable. Considering the data presented in Figures 2-12, 2-15 and Table 2-16, it would appear that there have not been significant changes in the water quality in the vicinity of the site over the last decade.

2.5.3 Hydrogeological Overview

The proposed location of the mine is underlain by the three major regional hydrostratigraphic units, the Pictou Group, the Stellarton Series and the Riversdale Group, which are considered capable of being utilized as a groundwater resource. These units are capable of producing relatively large quantities of potable water. Currently, most domestic wells in the area appear to be located in the Pictou or Stellarton hydrostratigraphic units. In general, water from those wells located in the Stellarton Series has inferior water quality, due to high levels of iron, manganese and total dissolved solids.

Hydrogeo (1981) in their analysis of the bedrock flow at the site indicate that the transmissivity of the Stellarton Group has been increased locally due to mining and other man-made influences. In addition, Hydrogeo indicates that local bedrock flow directions have been influenced by mining in the area (Figures 2-12, 2-16).

Figure 2-12 shows the location of residential wells, the observation well (OB-1) and the wells pumped (P2 and P3) during Hydrogeo's four month pump test at the site. During this pump test, according to Hydrogeo (1981) they drew the water level down to the Foord coal seam and maintained it in that vicinity for approximately three months. In their conclusions, Hydrogeo states: "There was no evidence of drawdown in observation well OB-1 due to pumping of Algas wells P2 and P3 after 4 months of pumping. Thus there appears to be no danger of lowering water levels in adjacent domestic wells".

TABLE 2-1

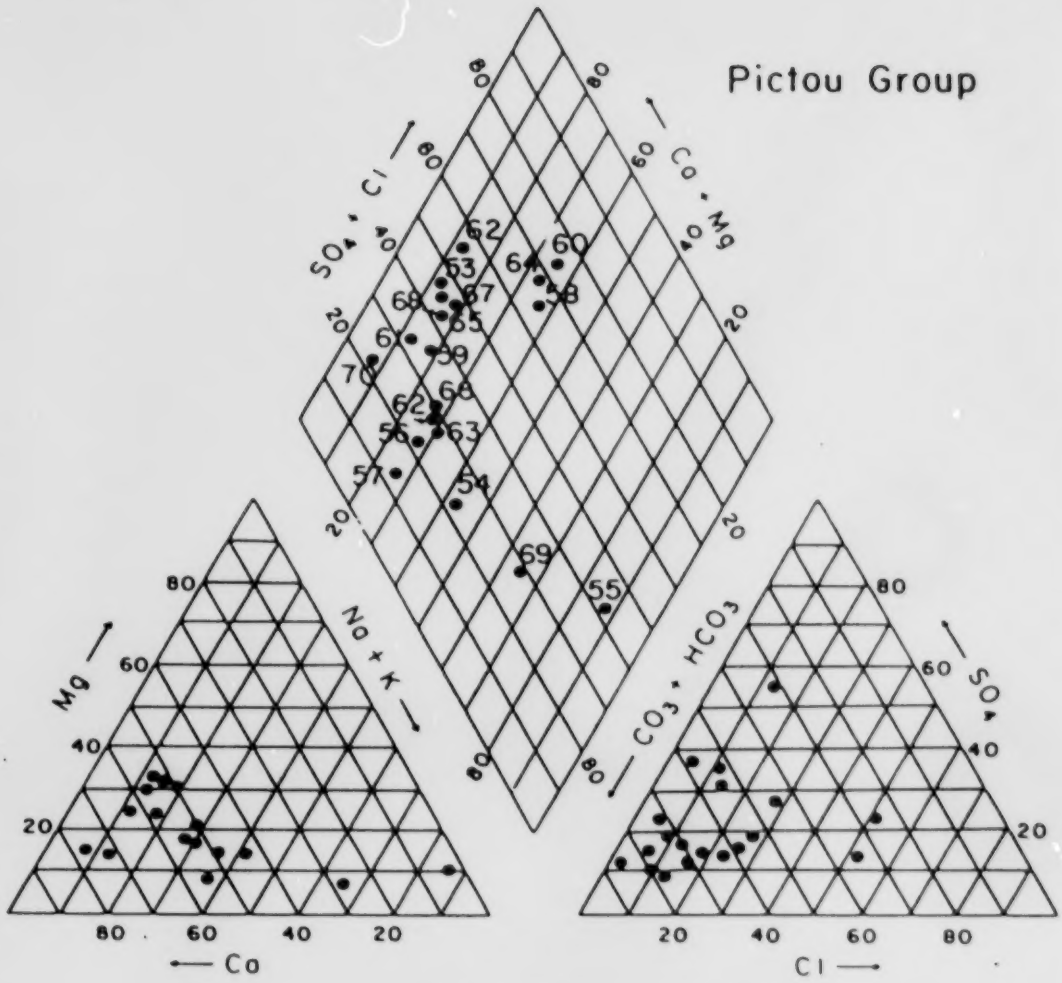
Comparison of 1980 and 1992 Residential Well Water Quality Data
February 1980
January 16, 17, 20, 1992

Groundwater Chemistry

PARAMETER	UNITS	DAKENS 1980*.	DAKENS 1992**	MACKAY 1980*	MACKAY 1992**	GOSBEE 1980*	GOSBEE 1992**	KILBURN 1980**	KILBURN 1992**
Sodium	mg/L	25	32.6	112	70.5	43	76.9	73	114
Potassium	mg/L	3.1	3.6	0.9	1.7	1.1	2.2	4.2	5
Calcium	mg/L	40	50	1.6	16.2	3.4	14.3	74	129
Magnesium	mg/L	7.8	9.4	0.3	4	0.8	4.2	11	18.3
Alkalinity	mg/L	185	170	275	130	160	130	150	140
Sulfate	mg/L	8.5	13	7	32	9	6	25	28
Chloride	mg/L	12	35.8	8	26.7	20	55.7	180	330
Silica	mg/L	13	13.9	8.3	12.1	13	13.3	13	13.1
Ortho Phosphate	mg/L	<0.02	<0.01	1.1	<0.01	0.39	<0.01	0.03	<0.01
Nitrate+Nitrite	mg/L	0.08	<0.05	<0.05	0.38	<0.05	<0.05	<0.05	0.09
Ammonia	mg/L	1.14	1.3	0.39	0.16	0.43	0.97	0.6	0.72
Iron	mg/L	0.39	0.06	0.45	0.09	1	2.74	8.9	1.23
Manganese	mg/L	0.2	0.29	0.02	0.03	0.09	0.36	1.5	1.39
Copper	mg/L	0.02	<0.01	<0.01	<0.01	0.02	<0.01	0.03	<0.01
Zinc	mg/L	<0.01	0.02	<0.01	0.01	0.01	<0.01	1.7	0.18
Colour	TCU	5	<3	15	<3	30	<3	15	30
Turbidity	NTU	1.9	4.45	2.9	1.99	5.6	29.2	30	16.6
Spec. conductance	umhos/c	340	496	450	432	330	469	810	1430
pH	Units	7.6	7.4	8.5	7.6	7.5	7	7.4	7.1
Hardness	mg/L	133	164	512	56.9	12	53	230	397

Note:

TCU = True Colour Units
NTU = Nephelometric Turbidity Units
mg/L = milligrams per litre (equivalent to parts per million)
umhos/cm = micromhos per centimetre
* 1980 data collected by Hydrogeologists for Algas Resoures
** 1992 data collected by Nolan, Davis for Westray



Per cent of total equivalents per million

Adapted from Gibb and McMullin (1981)

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FIGURE 2-17
TRILINEAR DIAGRAM
FOR WELLS SCREENED IN
PICTOU GROUP

JUNE, 1992

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Figure 2-15 shows a cross-section through the site from south to north. To aid in interpreting the site hydrogeology, the pumping and observation wells from Hydrogeo's pump test and Foster Avenue Extension have been projected onto the cross-section. The observation well, OB-1, is located between the site and the domestic wells on Foster Avenue and is cased at approximately the median depth of the domestic wells in the area. As can be seen from Figure 2-15 there is over 100 metres of relatively impermeable shale and siltstone between the bottom of OB-1 and the Foord Seam (the zone being pumped). Consequently, it would appear physically possible that the pumping of the Foord seam performed by Hydrogeo might not have affected OB-1 and that the proposed operation would therefore not impact existing wells.

The Hydrogeo long-term pump test was conducted from July to December, 1980 which overlaps with the season when groundwater levels are typically at their lowest. During this test, there was no indication that any of the local residential wells had a noticeable reduction in water quantity. This would indicate that fracturing in the immediate vicinity of the site is not a problem.

2.6 Terrestrial Environment

2.6.1 Overview

An environmental inventory prepared for the site included analyses of soil drainage conditions, surficial hydrology, vegetation and wildlife. Aerial photographs from 1990 were used to initially categorize the area for detailed field study. The NS Wetland Atlas was also used to identify wetlands; all wetlands identified in the atlas were investigated. Areas targeted as a result of the inventory analysis were verified in the field and biologically inventoried. Site visits were made during the week of May 19-22, 1992 and on June 15, 1992. The study area was bounded by Foster Avenue extension, Foster Avenue, MacGregor Avenue, North Main Street and the Canadian National rail line (Figure 2-18).

Soils in the area are high in sand and silt and are easily eroded when disturbed. Steep slopes in excess of eight percent gradient occur in the western portion of

the site. The remainder of the site slopes gently to the north, east and south. To the west surface runoff drains into Bear Brook. The water-gathering slopes (swales) and Bear Brook show signs of sediment deposition as a result of erosion.

2.6.2 Vegetation

The majority of site vegetation is in an early stage of succession (pioneer), likely resulting from past disturbance logging, land clearing and fire. Evidence of logging and fire was noticed during field observations. The majority of trees on site are shade intolerant hardwoods (red maple, large-toothed poplar) followed by scattered shade intolerant softwoods (white spruce, white pine, red pine). Balsam fir, a moderately shade tolerant softwood, occurs in limited numbers. The bracken fern plant association is the dominant ground cover and the cinnamon fern plant association occurs in poorly drained areas. Forest and ground cover vegetation observed within the study area is common throughout Nova Scotia. A detailed species list is provided in Table 2-18 with species abundance calculated according to overall site occurrence.

2.6.2.1 Forest Habitats

The upland well-drained sites support shade intolerant hardwoods (Figure 2-18). Large-toothed poplar and red maple are the dominant species followed by trembling aspen and gray birch. Softwood species are less numerous than the hardwoods and include white spruce (dominant) followed by scattered red and white pine. This forest is in an early stage of succession and is a result of disturbance through fire. Evidence of the burn exists on the red pines that survived the fire. The maples and poplars are some of the first species to recolonize areas disturbed by fire because they are able to cultivate through root sucklers, undamaged from the burn. The white pines growing in the area were seeded from adjacent older white pines occurring in the forest stands on the lower slopes of the site. The ground cover plants of this forest type belong to the bracken fern association.

The drainage swales support red maple as the dominant species followed by scattered large-toothed poplar, gray birch, white spruce and balsam fir (Figure 2-18). The

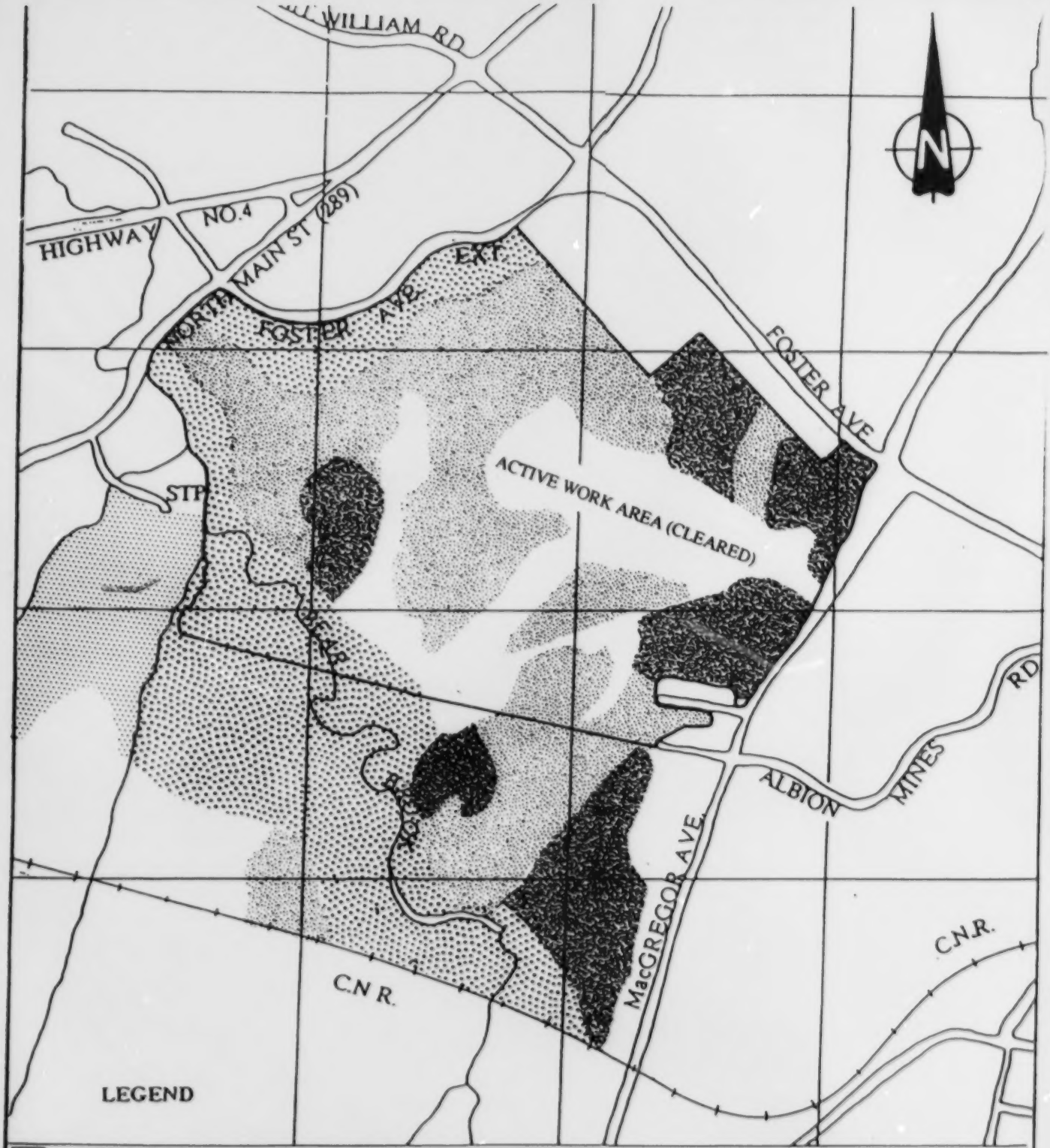

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FIGURE 2-18
TERRESTRIAL VEGETATION
WESTRAY STELLARTON PIT MINE

TABLE 2-18

Site Vegetation

Vegetation Type	Common Name	Scientific Name	Site Abundance
Softwoods	Balsam Fir	Abies balsamea L.	uncommon
	White Spruce	Picea glauca	scattered
	White Pine	Pinus strobus L.	scattered
	Red Pine	Pinus resinosa	scattered
	Larch	Larix laricina	scattered
	Jack Pine	Pinus banksiana	uncommon
	Red Spruce	Picea rubens Sarg.	uncommon
Hardwoods	Red Maple	Acer rubrum L.	common
	Large toothed poplar	Populus. grandidentata, michx	common
	Trembling Aspen	Populus. tremuloides michx.	scattered
	Red Oak	Quercus borealis michx. f.	uncommon
	Gray Birch	Betula populifolia	scattered
	White Birch	Betula papyrifera marsh	common
Woody Shrubs	Sweet Fern	Comptonia peregrina	scattered
	Pincherry	Prunus pensylvanica	common
	Mountain Maple	Acer spicatum	uncommon
	Withrod	Vibernum cassinoides	common
	Lambkill	Kalmia angustifolia	common
	Rhodora	Rhododendron canadense	scattered
	Trailing Arbutus	Epigea repens	scattered
	Blueberry	Vacciniuum angustifolium	common
	Honeysuckle	Lonicera canadensis	uncommon
	Meadowsweet	Spirea latifolia	uncommon
	Wild Sarsaparilla	Aralia nudicaulis	scattered
	Chokeberry	Aronia sp.	uncommon
	Shadbush	Amelanchier sp.	scattered
	Witch-hazel	Hamamelis virginiana	scattered
	Yew	Taxus canadensis	rare
Herbs	Pink Lady's Slipper	Cyripedium acaule	common
	Yellow Clintonia	Clintonia borealis	scattered
	Canada Mayflower	Maianthemum canadense	scattered
	Snowberry	Gaultheria hispidula	uncommon
	Teaberry	Gaultheria procumbens	scattered

(Cont'd)

TABLE 2-16(Cont'd)

Site Vegetation

Vegetation Type	Common Name	Scientific Name	Site Abundance
Herbs	Painted Trillium	Trillium undulatum	uncommon
	Meadow-Rue	Thalictrum polygamum	uncommon
	Goldthread	Coptis trifolia	uncommon
	Violets	Viola spp.	uncommon
	Star Flower	Trientalis borealis	scattered
	Bunchberry	Cornus canadensis	uncommon
	Prince's Pine	Chimaphalia umbellata	uncommon
	Common Strawberry	Fragaria virginiana	uncommon
	Common Buttercup	Ranunculus acris	scattered
	Marsh Marigold	Calthia palustris	uncommon
	Dogbane	Apocynum androsaemifolium	scattered
	Large-leaved aster	Aster macrophylius	scattered
	Lions paw	Prenanthes trifoliate	scattered
	Nodding trillium	Trillium cernuum	scattered
	Sedges	Carex spp.	scattered
	Jack-in-the-Pulpit	Arisaema stewardsonii	rare
	Sweet coltsfoot	Petasites palmatus	scattered
Ferns	Royal Fern	Osmunda regalis	uncommon
	Cinnamon Fern	Osmunda cinnamomea	uncommon
	Sensitive Fern	Onoclea sensibilis	uncommon
	Bracken fern	Pteridium aquilinum	common
	Osterich Fern	Pteretis pensyvanica	uncommon
	Crested Wood Fern	Dryopteris spinulosa	uncommon
	Interrupted fern	Osmunda claytoniana	scattered
Mosses etc.	Rheindeer Lichen	Cladonia rangiferina	scattered
	Sphagnum	Sphagnum spp.	scattered
	Haircap Moss	Polytrichum spp.	uncommon
	Schreber's Moss	Pleurozium schreberi	scattered

bracken fern plant association occurs on upper slopes of the drainage swales and the cinnamon fern plant association occurs on the lower slopes. The lower slopes of the swales tend to be wet and contain hummocks which trap and hold water creating unfavourable conditions for white spruce and balsam fir. Trilliums, violets, and the common lady's slipper were found at the base of the drainage swales.

The lower slopes and areas along Bear Brook support an early to mid-successional stage of forest. White pine and white spruce forest with red maple are the dominant hardwoods (Figure 2-18). Balsam fir is regenerating within the forest stand. The ground cover consists of the bracken fern plant association. The oldest trees in the study area occur within this forest. The pines and spruce reach an average height of 15 to 18 metres.

West of Bear Brook is primarily white pine, white spruce, and large-toothed poplar forest (Figure 2-18). White spruce and white pine are the dominant forest cover with scattered large-toothed poplar and the occasional red maple. This forest occurs on well-drained soils and is in a mid-successional stage. Balsam fir is regenerating in small pockets throughout this forest. The bracken fern association is the dominant ground cover.

Residential areas occur along the periphery of the site and are frequently associated with abandoned fields. Many of the old fields contain remnants of introduced plants and cultivated herbs. A detailed list of these plants was not compiled. Maples, poplars and the occasional white pine and white spruce are beginning to recolonize the abandoned fields.

2.6.2.2 Wetland Habitats

No wetlands on the site were identified in the NS Wetlands Atlas (NS Dept. of Lands and Forests, 1982), however, a small swamp exists in the northwest corner of the site, east of Bear Brook (Figure 2-19). This swamp covers about 0.5 hectares and contains a small area of open water with marsh marigold, surrounded by horsetails, club mosses, jack-

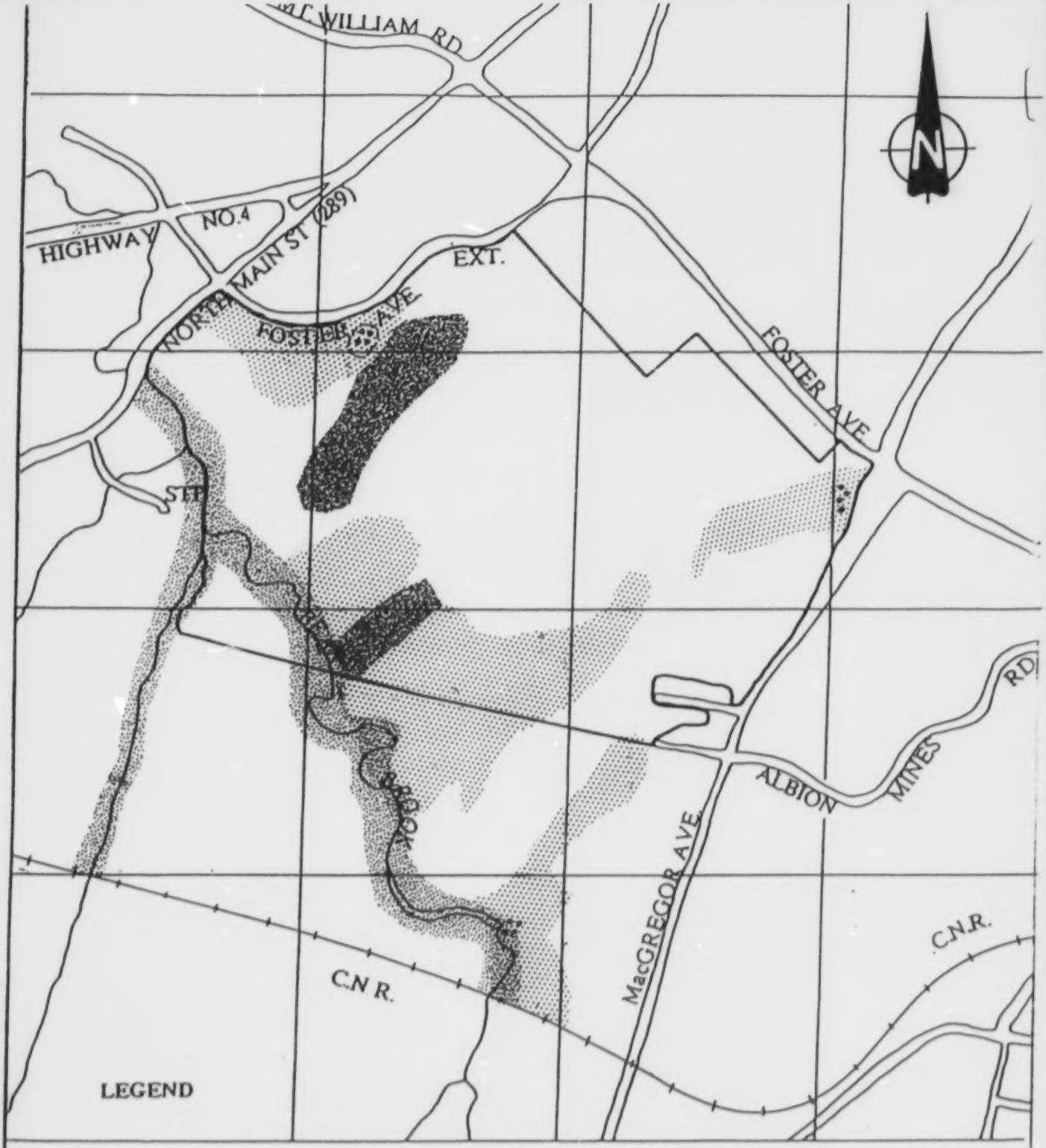

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FIGURE 2-19
ENVIRONMENTALLY SENSITIVE AREAS
WESTRAY STELLARTON PIT MINE

in-the-pulpit, shagnum and occassional red maple and black spruce. Tires and otehr garbage were observed in the open water section of the swamp, possibly carried from the nearby roadside ditches which drain into the swamp. This swamp, as with the drainage swales, supports numerous violets and orchids and is sensitive to disturbance. The NS Wetlands Atlas does not identify this wetland or others near the site, as having significant value to wildlife.

2.6.2.3 Sensitive Areas

Environmentally sensitive areas within the study site include the streamside vegetation along Bear Brook, watergathering slopes, and slopes in excess of eight percent gradient (Figure 2-19). These slopes are susceptible to erosion if disturbed. Bear Brook already exhibits signs of sediment deposition as a result of increased runoff and erosion from past excavation activities in the area likely associated with historic mining activity in the area.

Orchids were observed in a few remote sections of the site (Figure 2-18). The orchids observed at the time of the first survey were too small to be definitively identified and thus a second survey of the areas containing orchids was conducted on June 15, 1992. This latter survey identified the orchids as the common lady's slipper, a relatively common forest orchid. No rare or endangered plant species were observed during any of the field surveys.

2.6.3 Wildlife

Wildlife habitats within the site are capable of supporting large mammals only on a migratory basis; habitat in general is most suited to small mammals. During site visits evidence of small mammals were observed. Site observations are combined with the Department of Natural Resources Pictou County Fur harvest calculations from license returns and fur buyer slips(1990-91).

2.6.3.1 Game Animals

Common game animals harvested within Pictou County include white-tailed deer, snowshoe hare, grouse and pheasants. In 1990, 1,049 deer, 3,772 hare, 3,152 grouse, and 75 pheasants were reported harvested in the county (NS Department of Natural Resources statistics). Muskrat, beaver, raccoon, coyote and fox make up about 92 percent of the furbearing harvest in Pictou County (NS Department of Lands and Forests statistics). Game animals found on the site at some times of year probably include whitetailed deer, coyote, racoon, beaver, muskrat, otter, mink, bobcat, snowshoe hare, red fox, weasel, red squirrel, ruffed grouse, and pheasant. Only signs of coyote and snowshoe hare were observed in the forest during the site visit. A muskrat colony was observed in the west end of Bear brook (southeast corner of the site).

2.6.3.2 Non-game Animals

Tracks of non-game mammals were observed on the site and probably represent short-tailed shrew, meadow jumping mouse and/or the meadow vole.

2.6.3.3 Birds

The Maritimes Breeding Bird Atlas provides estimates of abundance of birds based on the observation of experienced volunteers between 1986 and 1990. These data are available by ten kilometre by ten kilometre squares. The study area is centred within one of these squares roughly bounded by Trenton and Churchville to Union Centre. Data were based on 1987 and 1989 observations. Birds observed in this area include green-winged teel, American black duck, killdeer, rock dove, barred owl, chimney swift, tree swallow, barn swallow, American crow, common raven, veery, American robin, starling, red-eyed vireo, Tennessee warbler, Nashville warbler, yellow warbler, Cape May warbler, and the black and white warbler. These observations indicate that the area is relatively limited in its diversity of birds.

2.6.4 Land Use

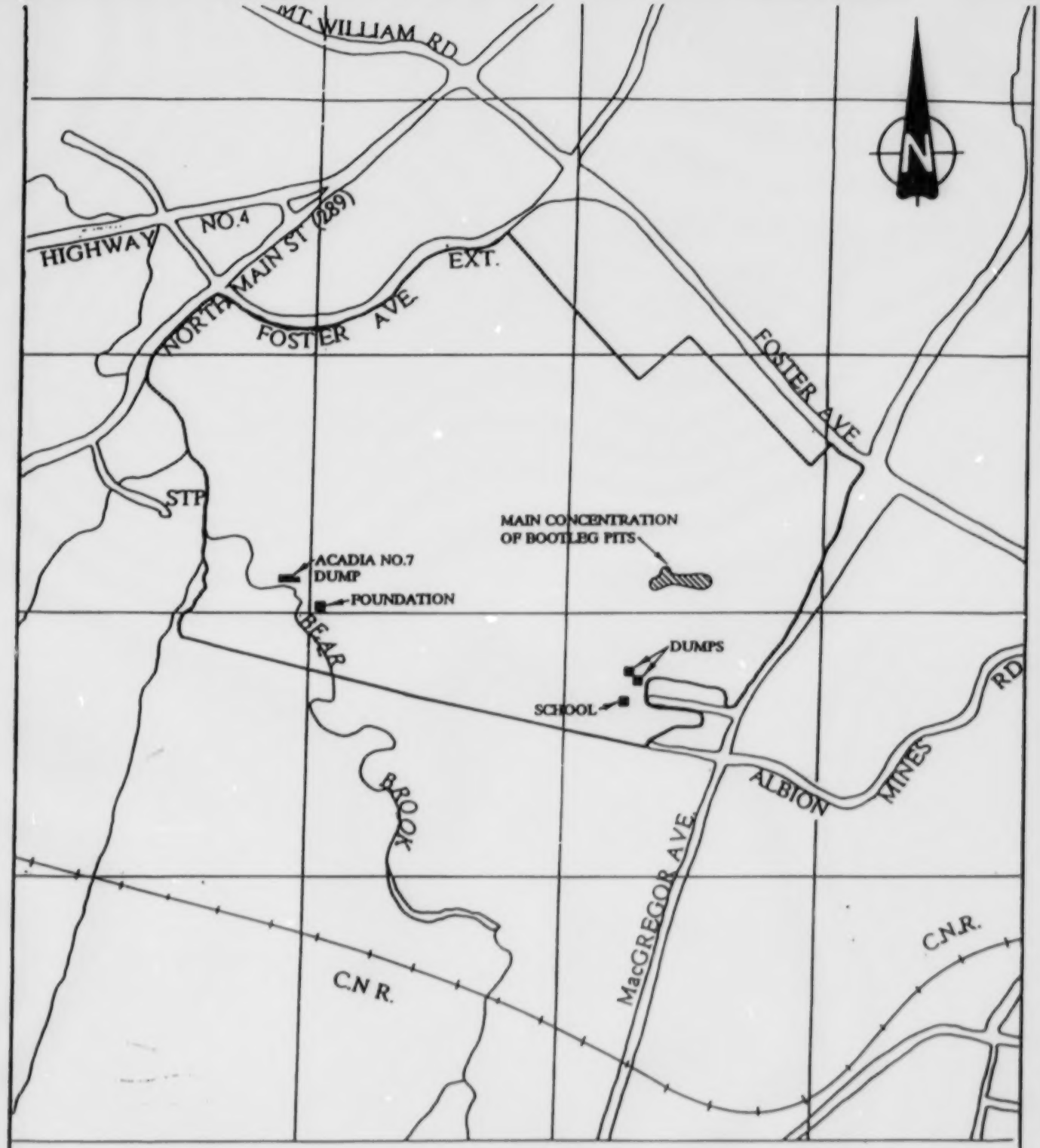
Land use within the proposed mining block is restricted to resource development based on M2 zoning by the Nova Scotia Department of Natural Resources. The majority of the site is in a forested state, dissected by numerous old roads and there is widespread evidence of old mining operations. Abandoned fields and small family farms are located west of Bear Brook. The initial excavations for the Bulk Sampling Program are located in the middle of the site. The Bulk Sampling Program uncovered five potentially dangerous abandoned shafts and this area is locally regarded as being very hazardous due to unmarked pits and shafts. It is therefore currently of very little value for development or recreational purposes.

Despite these concerns, some local residents have indicated that the site has been used by some as a recreational area for walking, berry picking and, in the past, fishing in the headwaters and low reaches of Bear Brook. There is also evidence of unauthorized four-wheel drive vehicle activity throughout the site.

2.7 Archaeological Resources

The cultural resource assessment of the area encompassing the Stellarton Pit Mine involved two sets of research activities. The first was a background historical document survey combined with informant interviews. The second was an archaeological field reconnaissance of the entire study area. This involved three experienced archaeologists traversing the 50 hectare study area locating and recording archaeological resources; i.e. foundations and historic dumps. The field data was checked against that collected by the project historian. These activities led to the identification of a mid-twentieth century mining complex, associated dumps, the remains of a school and an area comprised of collapsed bootleg mining activities.

The old mine complex (Figure 2-20) was identified as the workings of Acadia No. 7 (1936-1947) and is represented by four features. Feature number one is thought to be the portal of the mine, characterized by three concrete walls emerging from a bank of coal



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NOLAN, DAVIS & ASSOCIATES

FIGURE 2-20
ARCHEOLOGICAL RESOURCES
STELLARTON PIT MINE
STELLARTON, NOVA SCOTIA

JUNE 1992

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tailings; . Feature two is a concrete structure with protruding rebars which has been partially buried and disturbed. Although its function is unknown, its location suggests that it was the base for a structure used in loading coal on trucks or rail cars. The third feature in the complex is 45 metres north of the portal on the summit of the coal tailing mound. It is believed to have been the location of the fan shaft. The final feature of the complex is a rectangular concrete foundation located 57 metres from the northeast corner of Feature 2. It measures 2.98 metres by 7.62 metres with a concrete fabric identical to the other features. Its function is unknown.

The study area is the location of numerous dumps which can be categorized as being of two types; domestic and mining related. The principal area of domestic dumps lie north of Lehigh Street in the vicinity of the transmission line. These appear to have been used by the residents of the houses along Lehigh Street; contents include fairly modern debris ranging from television sets to plastic containers.

The major area for debris from mining activities is situated along the bank between the road to Acadia No.7 and Bear Brook. Isolated finds of miner's equipment have been made throughout the study area with no significant concentrations other than that below Acadia No.7. The collapsed shafts and bootleg pits have also been used to dispose of derelict automobiles.

The remains of the Lehigh Street school are represented by a rectangular concrete foundation. The school was in use during the 1940's (local informant). It is located just outside the study area and thus was not pursued in detail.

An area of social historical interest was shown to the team by a local, self-professed "bootleg miner". It was the location of bootleg coal mining activities characterized by collapsed pits (Figure 2-20). The same informant identified that a gas furnace was situated in this area. It's location could not be determined by surface features given the extensive degree of subsidence in the area.

Westray has adopted the practice of collecting all mining artifacts uncovered in the course of the Bulk Sampling Program and will donate these to the museum.

2.8 Social Environment

The proposed site of the surface mine operation is situated in the northwestern corner of the Town of Stellarton boundary. Twenty-seven residential, single-family dwellings are located in the immediate vicinity of the proposed operation along Foster Avenue, Foster Avenue Extension, MacGregor Avenue (Evansville) and the intersection of Foster and MacGregor Avenues. This location provides a semi-rural life style with many of the benefits associated with the urban services available to them.

The history of coal mining in Pictou County is well documented and forms an integral part of this area's heritage. Coal was first mined in Stellarton as early as 1792. The Foord Seam was first worked in the 1830's. It is very common for people in the area to readily identify themselves as part of a mining community despite the fact that the Westville operation has been the only active mine for more than two decades prior to the startup of Westray's Plymouth mine.

The economy of Pictou County is heavily weighed towards manufacturing, which in 1986 accounted for 22.8 percent of the regional labour force. Community, Business and Personal Services accounted for 25.9 percent of the labour force and Trade for 18.9 percent. Major industries in the area are the Michelin tire plant at Granton, which employs more than 1800; the Trenton rail car works employing 800; Scott Maritimes pulp and paper plant employing 500; Pictou Industries shipyard employing 350 and Maritime Steel & Foundries employing 150. However, many of the industries have employees on longterm layoff due to lack of work.

Available employment statistics for the Town of Stellarton indicate an unemployment rate of 18 percent. These figures are based on the 1986 census by Statistics Canada which records the population of the Town of Stellarton at 5,237 people.

A recent survey of local public attitudes is included as Appendix 3, and indicates support for the project by a margin of two to one.

2.9 Overview of Existing Environment

The proposed mine site is situated in the northwestern corner of the Town of Stellarton on a 50 hectare area of land that is essentially derelict as a result of past mining activity, although it is now overgrown with immature trees and shrub except in the area developed for the Bulk Sampling Program. There are approximately 27 homes in the close proximity of the site, the residents of which have enjoyed a semi-rural life in recent years. These factors result in some sensitivity having to be assigned to social, noise and air quality issues. Groundwater is also an area of concern due to there being a number of wells which could be potentially impacted by the proposed mine; although town water is available in the area.

The site is situated on a watershed divide but once developed will discharge the minewater and any contaminated site runoff into Bear Brook, a tributary of the Middle River which supports a fishery and is used for water supply. Thus, water quality must be considered a sensitive element of the existing environment.

2.9.1 Valued Environmental Components

In summary the following can be regarded as Valued Environmental Components on the basis of the assessment undertaken to date:

- social environment
- air quality
- noise
- groundwater
- surface water quality
- Middle river fishery resource

PART THREE

ENVIRONMENTAL IMPACTS

3.0 ENVIRONMENTAL IMPACTS

This section of the report identifies areas in which the project as described in Part One might interact either positively or negatively with the existing environment. The way in which potentially negative impacts might be mitigated are reviewed separately in the subsequent section of the report (Part Four).

3.1 Air Quality

3.1.1 Suspended Particulates

Without specific mitigation, the impact of suspended particulates (dust) can be a major source of concern for an operation such as that proposed. Fugitive particulate emissions can result from the mining operation itself, including activities such as truck loading; from wind eroded particulates and vehicular suspension of dust on site roads and storage piles; losses from uncovered truck loads, and resuspended particulates from vehicular traffic on dirty or unpaved roads. Specific mitigative measures to address these potential impacts are discussed in Section 4.1. Data from the Bulk Sampling Program dust monitoring program presented in Section 2.3.3.2 indicates that levels of suspended particulates can be controlled to regulated levels consistently, but also determined that on windy dry days, these levels would be exceeded if the level of control lapsed in any way.

Air quality impacts from suspended particulates can also arise from the burning of site clearing debris. Where this is practised, significant amounts of particulates are released. In addition various amounts of gases and trace toxic compounds are generated due to the low fire temperatures achieved during open burning. The updraft created by the fire readily suspends fine particles causing wide dispersal. Depending on meterological conditions and the methods employed, waste burning can result in impacts on adjacent sites.

Another source of suspended particulates and other substances is vehicle exhaust emissions. These however are likely to be quite localized in the context of the proposed operation.

3.1.2 Other Air Quality Impacts

While suspended particulates is by far the main potential air quality impact of concern, other emissions such as hydrocarbons, sulphur dioxide, PAH's and nitrous oxides from vehicle exhausts may be of lesser concern on occasions. Burning of slash associated with site clearing can, on the other hand cause relatively severe off-site impacts if employed.

3.2 Noise Impacts

Since there will be no blasting operations at the site, the primary source of noise, will be from trucks and other mining equipment.

Noise is generated by several different aspects of vehicle operation. During heavy truck acceleration, noise from the exhaust, engine and fan predominate almost equally but in that order of dominance.

Mine equipment noise is similar to that of heavy duty truck traffic. Differences occur from the height of the motor noise from the ground surface and differences in muffling that can occur either due to design or maintenance procedures.

3.2.1 Impact Factors

Interference from unwanted sound can impact in three ways. These impacts can include: annoyance, speech interference and sleep interference. Early research into the effects of noise concentrated on steady noise or single event noise. More recent research has gone into identifying the effects of variable noise such as that created by construction or traffic.

NSHRP studies of annoyance versus noise have found, that slight annoyance with noise occurs at L_{eq} levels in the range of 45 to 60 dBA. A very high level of annoyance occurs at levels of from 60 to 70 dBA and extreme annoyance occurs from 70 dBA on up. The range of reactions depends on the individual sensitivities of the receptor and the nature of the noise. For example, at a given L_{eq}, annoyance decreased with the overall variability

in the level of the noise.

Speech interference annoyance starts at 45 dBA going to 60 dBA where comprehension of the speech is only moderate. Normal voice communication with high intelligibility can take place at 56 dBA while good comprehension for a "relaxed" voice will occur at 47 dBA. At low levels of noise, annoyance is related more to interference with speech, however, at higher levels (that is, greater than 60 dBA) annoyance is more related to the nature of the noise itself.

Study on noise effects on sleep indicate that continuous equivalent noise levels in excess of 37 to 40 dBA, in the building, will cause sleep disruption while intermittent noises up to approximately 48 dBA are unlikely to cause disturbance. However, at approximately 54 dBA, noise occurrences can cause sleep disturbance. These guidelines will vary according to the receptor.

The location of the receptor has a bearing on reaction as well. More noise can be tolerated outside and response will vary according to the amount of time that receptors spend outside. Noise can be abated while passing from the outside to the inside of a structure to a level where little annoyance takes place inside the building. An additional parameter which determines the impact of a change in noise environment is the magnitude of the change from the original levels that the receptors have grown accustomed to.

Sound levels have been monitored around the proposed mine site at fourteen locations as reviewed in Section 2.3.4. The average levels recorded were consistently below the 65 dBA limited allowed. Infrequently the Leq level exceeded the 65 dBA limit.

None three of the average Leq sound levels recorded between January and April 1992 are above 65 dBA. However, a number of the daily readings are high, indicating that several locations at times have received significantly elevated and consistent sound level impacts.

Mitigation of noise at the proposed operation is discussed in Section 4.2.

3.3 Surface Water Impacts

3.3.1 Physical & Chemical Impacts

Table 3-1 identifies the potential impacts which could arise from mining activities during the operational phase. Exploration and construction phases need not be considered as the site is already developed. It is also important to appreciate that there are other existing impacts on Bear Brook generated by urban/suburban storm runoff, treated sewage and abandoned mine workings.

The potential impacts identified in Table 3-1 should be considered negative with the possible exception of increased baseflows associated with reclamation. There is a relatively high probability that the following impacts would be "significant" if not mitigated:

a) increased sediment concentrations/loadings

b) alterations in water chemistry

These can result from either or both of the following:

a) surface water runoff

b) groundwater drawdown around the excavation

The former encompasses stormflow runoff as well as pit sump water (including inflowing groundwaters) which is directed away from the site to maintain suitable working conditions. This can be relatively easily controlled and treated with existing technologies to meet regulatory agency guidelines. In order to effectively reduce impacts on Bear Brook mitigation measures must be designed to meet three criteria namely: 1) reduce suspended and bedload sediment transport, 2) treat the dissolved water chemistry to acceptable criteria, and 3) provide temporary storage to ensure that peak storm flow runoff generated on-site does not enter the Brook simultaneously with natural peak storm discharge moving down the channel. If the latter occurred, some of the other potential impacts identified (including increase flooding, alterations in channel regime and channel erosion) would have a higher probability of occurrence.

Groundwater drawdown entails the potential for reducing flows in Bear Brook by: 1) reversal of groundwater gradients beneath the Brook, such that streamflow infiltrates into the groundwater flow field or 2) alteration of the flow system so that the normal base groundwater inflow to the Brook is diverted elsewhere. Since all shallow and deep groundwater intercepted by the excavation are going to be discharged to Bear Brook, flow system alteration is not considered to be a major issue.

Table 3-2 identifies potential reclamation phase impacts. The extent and timing for alterations in water chemistry depend on the chemical and physical characteristics of the fill material utilized to backfill the excavation, and the time frame for compaction to reach a final equilibrium state.

3.3.2 Surface Water Biological Impacts

While Bear Brook could be affected by sedimentation or chemical contamination from mining activities if unmitigated, the fish resources of the Brook, primarily white sucker, are not particularly sensitive. While trout migrate through the area to better quality headwater streams, passage through the area currently occurs under less than desirable conditions.

The commercial gaspereau fishery in the Middle River impoundment is the most sensitive feature downstream of the proposed mine area. While it is highly unlikely sufficient contamination to jeopardize the gaspereau population could originate from the mine site, control of sediment and chemical discharge from the site remains important.

Salmon stocking occurs between the inflow of Bear Brook and the mouth of the Middle River. This represents a small portion of the enhancement area but excessive sedimentation in Bear Brook could reduce the habitat quality in this section of the Middle River.

TABLE 3-1
Potential Operational Phase Impacts
before Mitigation

Potential Impact		Mechanism
1)	Increased suspended/bed sediment loadings (with associated adsorbed chemistry)	• rainfall and rill/gully erosion of waste rock stockpiles • erosion within mine cut and subsequent pumping of sump to surface • erosion of drainage ditches • erosion of clear cut areas on advance of actual mining
2)	Increased peak storm discharge and decreased peak time/duration	• reduced evapotranspiration • reduced infiltration due to topsoil removal • more rapid overland flow due to ditching etc.
3)	Enhanced Flooding	• due to 2) above
4)	Stream Bank/bed erosion	• due to increased peak storm flows
5)	Reduction in base flows	• if dewatering cone from the excavation significantly intercepts stream channel
6)	Alterations in Channel Regime	• due to 1), 2), 3), 4) & 5) above
7)	Altered Water Chemistry	• bedrock groundwater inflow to mine pumped to surface • exposure and oxidation of bedrock on highwall with creation of acid drainage • flushing of oxidized, broken rock in above grade waste rock stockpiles (and possible acid drainage development) • remobilization of metals absorbed to sediment released from site due to change in water chemistry and/or sewage outfall, and low pH spring runoff
8)	Alterations in water temperature	• dependent upon 2) and 4) above

3.3.3 Spatial Zone of Influence

Although there is the potential for the mine activities to impact on Bear Brook and the Middle River system in general, there is in fact very little likelihood that any significant impacts will occur off-site due to the comprehensive drainage collection and treatment system which already exists and which will be expanded to meet the future development of activities on the site. Specifically, no impacts are anticipated in the Middle River, including the Middle River Impoundment.

As discussed in the following section, there is a possibility that the groundwater cone of depression will influence the flow regime of Bear Brook in the neighbourhood of the site but this will be compensated by the pond discharges during times they are pumped. Thus the spatial zone of influence of the project on the Middle River system will be confined to an area very close to, or actually on the mine site.

3.4 Potential Impacts to Groundwater

In general terms, the surface mining of coal is a disruptive process that can temporarily or permanently alter the local groundwater regime. Coal mining can have two major effects on groundwater: First, an initial decrease in the quantity of groundwater due to dewatering and second, an alteration in the quality of the groundwater due to chemical changes in the disturbed geological materials. The significance of the effects on groundwater will depend on the value of the groundwater resource; the hydrogeologic conditions in the mined area, and the amount and chemical characteristics of the geological material that is disturbed. This section briefly discusses the major potential impacts to groundwater which could occur at the proposed Westray surface mine and provides a preliminary evaluation of their potential significance. For these purposes a significant impact is considered one which could potentially adversely alter Bear Brook or the nearby domestic wells.

TABLE 3-2

Potential Reclamation Phase Impacts before Mitigation

	Potential Impact		Mechanism
1)	Increased suspended/bed sediment loadings (with adsorbed chemistry)	•	rainfall/rill erosion of reclaimed land surface
2)	Alterations on water discharge	•	potential enhancement of peak storm flows and decreases in their peak time/duration due to absence of vegetation over reclaimed surface
		•	potential enhancement of base flows from fill within reclaimed pit. Fill may act as a significant groundwater storage component draining into Bear Brook.
		•	potential reduction in base flow if drawdown cone is still present and significantly intercepts Brook
3)	Stream Bank/Bed Erosion	•	dependent upon 2) above
4)	Enhanced Flooding	•	dependent upon 2) above
5)	Alterations in Water Chemistry	•	increased total dissolved solids due to infiltration of water through a deep oxidized unsaturated zone within the reclaimed fill
		•	potential reduction on pH and increased metal concentrations if the fill becomes acid generating
		•	potential remobilization of metals absorbed into sediment released from the site and/or naturally in the channel depending on chemistry of off-site runoff.
6)	Alterations in Channel Regime	•	dependent upon 1), 2), 3), & 4) above

Potential impacts to the physical groundwater flow regime include:

- **changes in infiltration or recharge due to removal of vegetation and changes made to topography.** Any impact to be anticipated would have already occurred during the Bulk Sampling phase but will continue during the proposed mining phase. During reclamation this potential impact could be reversed. Based on the data available, the site is not the major recharge area for local groundwater users, consequently changes to infiltration patterns on the site should not have a significant impact. The drainage control system will mitigate any potential impact due to groundwater influenced changes in runoff and sediment loadings.

- **the lowering of the water table and piezometric surface which would ultimately result in changes to local bedrock groundwater flow directions.** This impact would occur during the mining phase and could potentially result in a dewatered zone with a radius of influence that might influence both Bear Brook and local domestic wells. However, based on the available data it is our professional opinion that the dewatering will likely not affect local domestic wells. A monitoring program is proposed in Section 4.4 to observe any potential changes before the wells would be affected and a backup contingency plan is also provided. Less than 15 residences in the immediate area rely on groundwater for their only source of water (see Figure 4-1). Impacts to Bear Brook due to drawdown are a possible concern in this regard but would be mitigated by the release of pit water after treatment back into the stream. In addition, a piezometer couplet is proposed as part of the monitoring program to observe any potential changes in the program to observe any potential changes in the hydraulic head adjacent to Bear Brook.

Potential impacts to the aqueous geochemical regime include:

- **contamination of groundwater through ancillary mining and construction related activities.** This potential impact would include spills of any kind (i.e.

petroleum hydrocarbon) or the release of any deleterious substances. The likelihood of any such events is very minor, so this potential impact is not considered significant.

- **oxidation of disturbed geological material can sometimes result in acid mine drainage.** This would cause a lowering of the groundwater pH, increased total dissolved solids and increased concentrations of various groundwater constituents, particularly iron, manganese and sulphate. However, the data presented in Section 1.4 indicates that the local bedrock is not expected to be acid generating so this is unlikely to be a concern. However, it is prudent to continue to monitor for potential acid generation and any potential impact to groundwater.

- **The alteration of groundwater flow directions could induce flow of contaminated groundwater from old mine workings in the area.** The exact layout of the old workings is currently poorly defined but this factor should concern only the mine operational aspects as all minewater will be pumped to the site drainage system and treated before release to the environment.

3.5 Terrestrial Environment Impacts

The terrestrial environment on the site is not of major value to forestry or wildlife, and no rare or endangered species have been identified on the site.

3.5.1 Land Use Impacts

Land use impacts will be positive in the long term in that the mine area will be entirely reclaimed to parkland and possibly donated to the Town of Stellarton for future use, thus reclaiming an area of the Town that is currently derelict and a danger to recreational and other use categories.

3.6 Archaeology

With the exception of the Acadia No.7 mine complex, no significant archaeological resources were identified within the boundaries of the proposed mine. Consultations with the proponents indicate that this area, being on the edge of the proposed development, will not be impacted. Furthermore, it is known from the historical documentation studies that this mine was closed and not abandoned. Thus its equipment was removed from the site and the shafts allowed to collapse.

The proponent has initiated the collection of mining artifacts found on the site. These will be donated to the museum for curation. It is the professional opinion of Davis Archaeological Consultants Limited that the proposed Stellarton Pit Mine will not impact on any significant archaeological resources.

3.7 Social Impacts

The mine will have both positive and negative social impacts. On the positive side it will provide long-term employment opportunities directly for 60 persons at the site plus any secondary benefits due to increased buoyancy of the local economy. It will provide increased local taxes and royalties to the Town of Stellarton and will allow currently derelict land to be returned to beneficial use.

The proposed operation will also have numerous secondary benefits, particularly since the accidental explosion at the Company's Plymouth mine. This incident has caused a total loss of the feed stock for the coal preparation plant which has therefore had to be closed with the loss of 164 jobs and the related loss of wealth into the community. The proposed Stellarton mine will allow the Plymouth coal preparation plant to recommence operations thus providing for employment of an additional 42 persons and allow Westray to continue to meet its contractual obligations to supply low sulphur coal to the Nova Scotia Power Corporation for combustion at its Trenton Generating Station.

On the negative side, local residents living close to the site will be impacted by the mining operation. Of 27 homes in the affected area, Westray has currently met individually with 25 families and has explained the compensation package the Company is prepared to offer (see Section 4.6) as well as the details of the proposed operation. The majority response is one of support for the project as long as proper controls and compensation are included. This support has been reflected in recent phone-in and TV shows in the area. An open house held in Stellarton on April 30, 1992 attracted 210 people and provided an opportunity to explain the project and answer questions. Again, the response was generally favourable.

There will also be some negative impacts associated with the trucking operation between Stellarton and Plymouth due to the increased density of heavy traffic, noise, and dirt on the roads (if not mitigated) and potential damage to the road surface if not properly maintained.

A recent public attitudes survey conducted in the area is included as Appendix 3, and shows that residents support the project by a margin of two to one.

3.8 Impacts at the Plymouth Site

The project will impose no additional or incremental impacts on the existing Plymouth mine site which is fully permitted to mine and process 1 million tonnes per year of coal. Due to the underground accident, production of coal at that site has ceased, meaning that the coal from Stellarton will replace the permitted feed for the Plymouth coal preparation plant. Waste from the plant and the control of site drainage will all be conducted within the terms of the existing permit with no incremental impact.

PART FOUR

MITIGATIVE MEASURES

4.0 MITIGATIVE MEASURES

4.1 Air Quality Mitigation

The two air quality impacts that require serious consideration are emissions resulting from site clearing/brush burning operations and the control of fugitive dust from the site and related trucking operations. The first issue is relatively simple and will not, in any case, be a long standing concern because much of the site is already cleared. Burning is still an accepted approach to site clearing in Nova scotia and is less costly than the alternative of chipping all wood waste. Mitigation should therefore centre on the timing of burning relative to the meteorological conditions and burning controlled quantities of brush so as to minimize off site impacts.

Dust control on the other hand requires careful and consistently applied mitigative measures throughout the life of the project if non-compliant or nuisance levels are to be avoided. Sources requiring specific mitigative measures include:

- mining operations such as ripping and loading
- on-site vehicle traffic on unpaved roads
- waste pile and other cleared area erosion
- mud and dust carry over onto off-site paved roads

4.1.1 Mining Operations

The control of fugitive dust from the mining operations must centre on provision of moisture control measures such as spraying with water when conditions are critical during periods of moisture deficiency and high wind. Operations based in relatively deep pits will not likely have much direct offsite impact but could contribute to general dust levels at critical times if not controlled.

4.1.2 On-site Vehicle Operations

On-site equipment operating on unpaved roads tends to elevate dust into the air where it is extrained by the wind. Even under adverse drying and wind conditions, wet suppression controls on unpaved surfaces can achieve 100 percent effectiveness if applied

consistently. However, the decay rate is high and will drop to zero effectiveness with several hundred vehicle passes unless maintained. Applying new gravel can provide longer lasting efficiencies approaching 75 percent. Paving is the most effective measure but is often impractical in mining operations due to the need to move haulage routes frequently. Speed reduction and the use of large haul vehicles so as to minimize trip frequency are also effective controls.

4.1.3 Wind Erosion of Waste Piles

Wind erosion from elevated waste piles containing finely divided material is a major source of dust at mine sites. Wind velocity, surface moisture content, compaction of the pile, particle size distribution and orientation of the pile to the wind are all factors influencing the emission rate (Watson et al, 1989).

Mitigative measures include design of the piles so that the long axis is aligned with the prevailing wind; reducing side slopes to less than 10 degrees in the direction of the predominating wind, compaction, wet suppression, chemical and vegetative stabilization of the surface, and the use of portable windscreens (which act in a similar fashion as snow fences by reducing surface wind velocities). In view of the relatively short life of the piles at the proposed operation, Westray proposes to use wet suppression as the primary mitigative measure for the waste piles at the site, with vegetative or coarse rock cover for any surfaces to be exposed for more than two years.

4.1.4 Carry Over Onto Highways

Trucks which are operating on unpaved roads can entrain as much as four kilograms of dust per kilometre travelled. Unless removed this can then be deposited on a paved surface as the truck leaves the site, as will be the case for the coal haul trucks. Subsequent traffic can then entrain this material causing a dust problem off of the mine site. The same applies to mud tracked onto the highway from the site during wet conditions. To mitigate against these problems, Westray will install a truck wash station at the access gate from the site and subject all trucks to inspection and washing.

4.2 Noise Mitigation

A number of dwellings in this rural urban area may be impacted by sound from the site as well as by vehicular traffic to and from the site. The following measures are available to mitigate noise effects.

- Reduce emission rates
- Provide noise barriers
- Alter operations
- Provide compensation

During the Bulk Sampling Program, it was found that nuisance level noise approaching the regulatory limit of 65 dBA Leq occurred primarily as a result of some heavy equipment operating at elevation on the waste pile and also that particularly intense noises such as the back-up warning alarms on some vehicles were intrusive. Off-highway trucks were found to vary considerably in the level and transmissivity of the noise they made depending on engine noise and the muffling system in place, particularly where elevations on the waste dump were concerned.

Mitigation will involve all of the measures described above. A 30 metre barrier will be maintained as a minimum between the farthest extent of the mine operations and any property line. The distance to any residences will therefore be considerably more than this. The majority of operations will occur in the pit which will provide excellent noise shielding. However as before, the potential source of nuisance level noise will occur from haul trucks and other equipment operating on the waste dumps. Mitigation in this case will involve altering haul routes around the 'back' (i.e. south side) of the dumps wherever possible; specifying the equipment with the best noise characteristics and muffling systems for this task, and modifying back up warning systems to be less obtrusive at distance. The general compensation package to be provided to any residents choosing to stay in the area is described in Section 4.6. This combination of measures should adequately mitigate this potentially sensitive impact. Noise monitoring will be continued as for the Bulk Sampling

Program and the results reviewed regularly with the Liaison Committee and regulators.

4.3 Surface Water Mitigation

The essential element in mitigating any impacts to the Middle River system is the extensive surface water controls and treatment system described in Section 1.4. With this system, all contaminated runoff on the site, including the mine water, will report to one of the treatment pond systems before discharge to Bear Brook. Each pond system will consist of two identical ponds to provide for batch treatment using flocculants as done during the Bulk Sampling Program. Consistently effective levels of treatment were achieved even during periods of peak runoff. The existing system will enable the site to be started up with no concerns or lag time while the expanded drainage system is commissioned.

Water quality monitoring on Bear Brook will be maintained in addition to the characterization of any discharge from the treatment ponds.

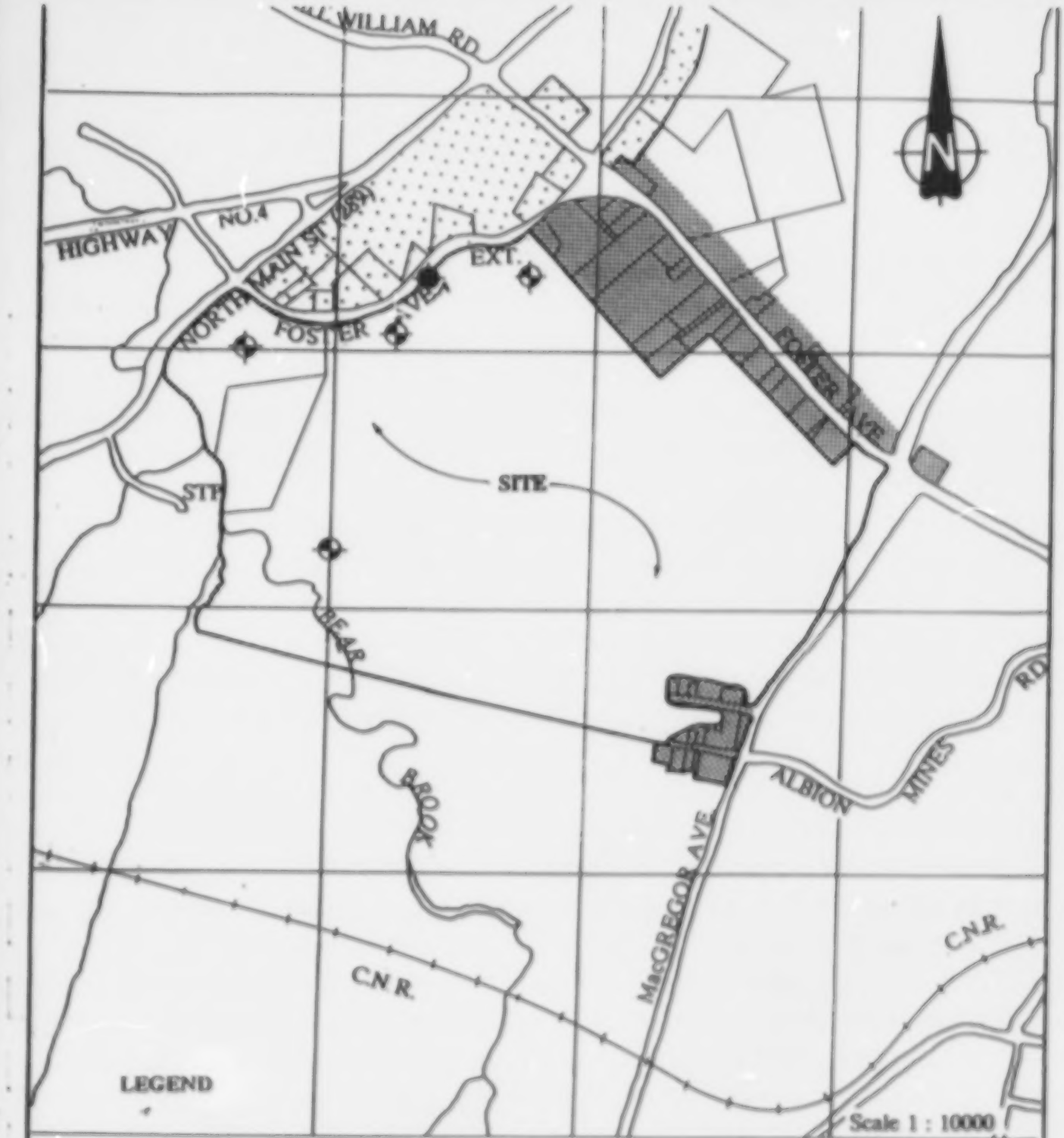
Non-active areas of the site will be stabilized by hydroseeding where final contours can be achieved or with chemical stabilizers where temporary control is required. The ongoing erosion control program proposed for the site is described in Section 1.4.1.

4.4 Hydrogeological Mitigation

No impact is expected to wells in the area of the mine. However to monitor this conclusion four monitoring wells will be installed between the mine and both the existing supply wells and Bear Brook. The existing Algas well will also be monitored. In this way any changes can be observed in sufficient time to provide mitigation to those dependent on groundwater supplies. The location of the proposed monitoring wells is shown in Figure 4-1. Any potential impacts on Bear Brook will also be detected by this program

In the event there is any impact to domestic water wells, Westray will provide appropriate compensation by either:

a) installing a new well; or



NOLAN, DAVIS & ASSOCIATES

FIGURE 4-1
LOCATION OF PROPOSED MONITORING WELLS AND RESIDENCES UTILIZING GROUNDWATER

JUNE 1993

b) connecting the dwelling to a water utility;

If a new well is installed, Westray will do all the work associated with the installation, including but not limited to; drilling of the well, supply and installation of well casing and well pump, and all electrical and mechanical connections required.

If the dwelling is connected to a water utility, Westray will do all the work associated with the connection including but not limited to: negotiations with the utility for service, supply and installation of buried pipelines, restoration of ground surfaces disturbed by pipe installation, and hook-up to the existing plumbing.

There are two potential impacts of groundwater to Bear Brook. The first is reduction in base flow due to the dewatering of the mining area. In order to monitor the groundwater in the immediate vicinity of the Bear Brook a piezometer couplet is proposed as shown on Figure 4-1. If monitoring of the hydraulic heads in these piezometers indicates a decrease in base flow to the stream, then waters from the sedimentation ponds will be released to mitigate this effect.

The second potential impact is changes in the surface water quality due to discharge of groundwater from the dewatering pumps into the brook. This will not have an adverse impact on the stream since all groundwater pumped from the dewatering system will be released to the sedimentation ponds where the quality and quantity of water released to Bear Brook is controlled.

4.5 Terrestrial Impact Mitigation

No specific mitigative measures have been identified other than the site reclamation plan described in Section 1.3.

4.6 Social Mitigation & Compensation

4.6.1 Compensation to Residents

As described in Part One, the project is located adjacent to several residences within the Town of Stellarton. Although Westray will do its utmost to mitigate the impacts on the local residents, it is recognized that there will be an inconvenience. In order to mitigate this inconvenience, Westray has, in consultation with the Citizens Liaison Committee, agreed to a compensation package to be provided to the residences adjacent to the mine.

Westray is offering compensation in several ways, depending on the location of the residence. These are:

a) property purchase,

b) start-up compensation,

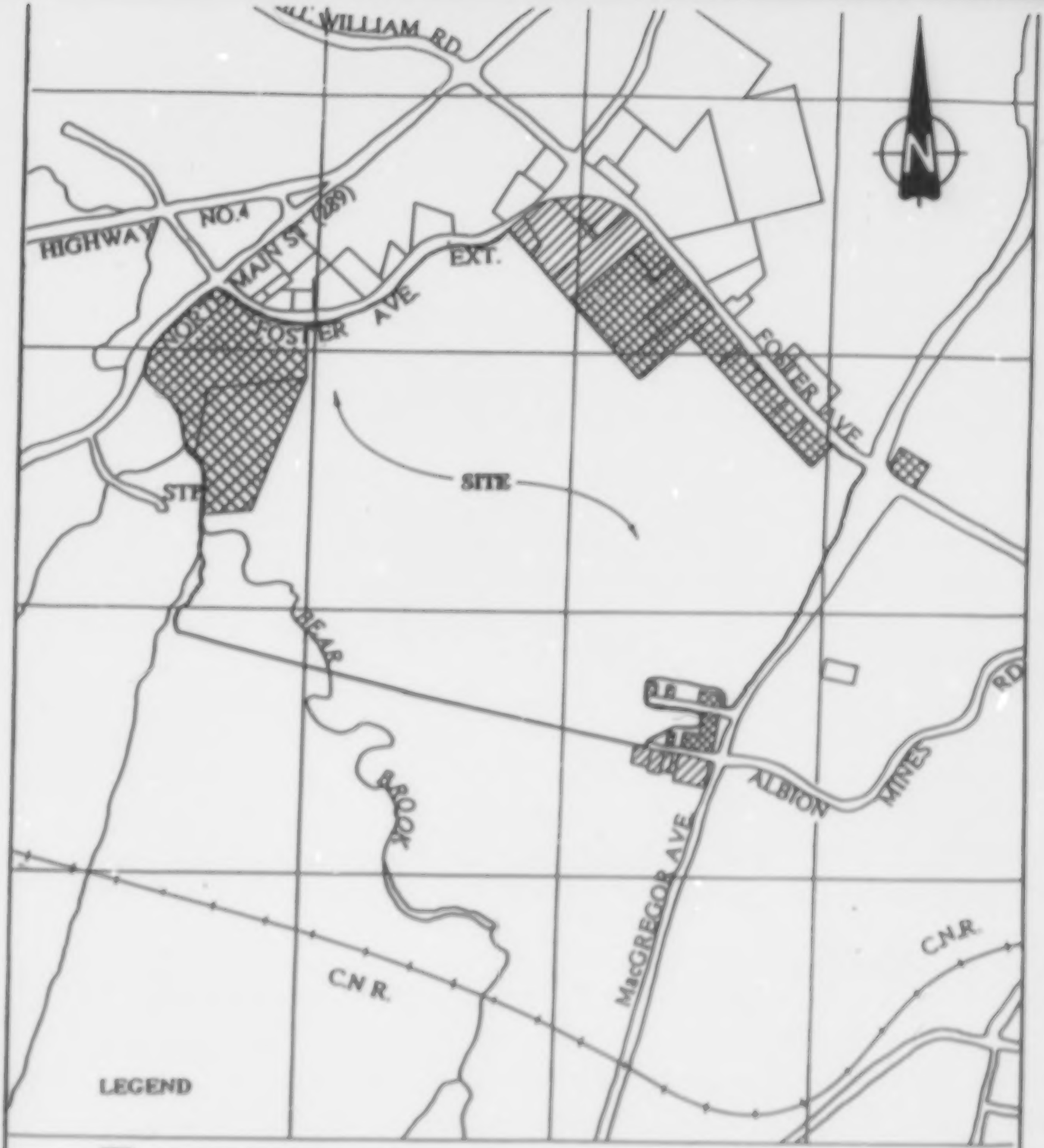
c) ongoing compensation, and

d) well loss compensation.

4.6.1.1 Property Purchase

Westray has begun negotiations with several of the local property owners for purchase of the property. The properties which Westray would like to purchase are shown on Figure 4-2. Westray has already entered into option-to-purchase agreements with several of these property owners. In these agreements, Westray has a set time in which to purchase the property at an agreed upon price. If Westray chooses not to purchase the property, the homeowner is under no further obligation.

It is Westray's wish to purchase all of the properties indicated on Figure 4-2, however the property purchases are not essential to the mine's operation. Should some of the property owners chose not to sell, Westray will then consider whether or not to exercise the options to purchase the remaining properties. In any event, Westray will respect the rights of the property owners, and will not in any way try to force the sale of any property.



NOLAN, DAVIS & ASSOCIATES

FIGURE 4-2
AFFECTED PROPERTIES
WESTRAY STELLARTON PIT MINE

JUNE 1991

4.6.1.2 Start-up Compensation

Westray has agreed to provide to the residents certain items to minimize the effects of the disturbance which the residents anticipate. In particular, Westray has agreed to provide a clothes dryer, vinyl siding, and a window air conditioner to affected residents. If a resident so chooses, he may accept a cash allowance in lieu of any of these items.

4.6.1.3 Ongoing Compensation

Westray has agreed to provide ongoing compensation to all affected residents. This compensation provides for the annual payment of property taxes and town water bills, plus an annual cash payment. In the case of the taxes and water bill, Westray will make this payment every year in which the pit is operating. Westray will make the annual cash payment every year in which the pit is operating.

Also, Westray will pay for cleaning inside and outside of homes which have been soiled as a result of dust from the pit or from trucking operations.

4.6.1.4 Well Loss Compensation

The compensation package proposed relative to impacted wells is described in Section 4.4.

4.6.2 Compensation to the Community

With the proposed mitigative measures in place, the project will have very little, if any, longterm negative environmental impacts. The land form of the area will obviously be seriously disrupted during the operation but will be reclaimed to useable land on a progressive basis. This, coupled with the employment and economic benefits which the project will provide to the area, are seen as major attributes of the project. Its development will also allow the Trenton Generating Plant to return to the use of low sulphur coal, thus reducing its effect on the atmospheric environment.

4.6.2.1 Infrastructure Damage

The project is not expected to impact transmission lines, water mains and other local infrastructure. However, it is possible that the increased level of trucking will cause some excellerated deterioration of non-highway standard roads, such as the East River Road. Should this occur, Westray will negotiate appropriate compensation with the local authorities for this cost of repair.

4.6.3 Information to Residents

Westray is committed to maintaining the Project Liaison Committee as a working mechanism of providing regular information to local residents and obtain input from them. This process has proven very effective during the Bulk Sampling Program. Westray will also deal with the Town of Stellarton and other governments on an open and cooperative basis.

4.6.4. Arbitration and Conciliation

Westray proposes to continue to use the project Liaison Committee as the primary vehicle for dealing with concerns of the local residents. This has been proven to work well during the Bulk Sampling Program and planning phase for this project when a number of potentially contentious issues were satisfactorily addressed and resolved. No other structural third party dispute settlement system is therefore felt to be required and none is proposed at this time.

4.7 Summary of Residual Impacts

Figure 4-3 provides a summary of positive and negative benefits for the development phase (which is already completed), mining, transportation and the post-reclamation phase. As can be seen from the diagram, most of the post-reclamation impacts will be positive and all other impacts are either mitigable or minor with the exception of the physical impact of mining on the land and the unavoidable impact of the increased level of trucking during the mining phase. The long term and operational impacts on groundwater will likely be minor.

FIGURE 4-3

Summary of Residual Impacts

	AIR		WATER			LAND			SOCIAL	
	AIR QUALITY	NOISE	SURFACE WATER	GROUNDWATER	FISH	TERRESTRIAL HABITAT	LAND USE	WILDLIFE	CULTURAL RESOURCES	SOCIAL
Development	○	○	○	•	○	•	●	•	•	•
Mining	○	○	○	•	○	•	●	•	+	○
Tranportation	•	•	N/A	N/A	N/A	N/A	N/A	N/A	N/A	●
Post Reclamation	N/A	N/A	+	•	+	+	+	+	+	+

Key:
- • Low Impact (Negative)
- ○ Significant Impact-Mitigable
- ● Significant Impact-Non-mitigable
- \+ Positive Impact
- N/A Not applicable

PART FIVE

PROPOSED MONITORING PROGRAM

5.0 PROPOSED MONITORING PROGRAM

As noted in Part Two of this report, scheduled periodic environmental monitoring of surface water chemistry, sound levels, air quality and groundwater chemistry have been carried out at and within the immediate surrounding area of the proposed operational area.

Subject to the approval of the regulatory agencies and the citizens Liaison Committee, Westray proposes to maintain the existing environmental monitoring network established for the Bulk Sampling Program. Utilizing this existing monitoring network will allow the mining operation to continue to gather comparative specific parameters under natural and site operating conditions. The proposed environmental monitoring program for this is presented in Table 5-1.

TABLE 5-1

Proposed Environmental Monitoring Program

Parameter	Location	Method	Frequency
Noise	at the fourteen stations (1-13A) presently monitored and established for the site Industrial Waste Permit, Approval No. 91-081.	Portable Audiometer	Three (3) times weekly during operation hours
Air Quality:	at the four stations (D1-D4) presently monitored and established for the Industrial Waste Permit, Approval No. 91-081.	Hi-Vol Particulate (Dust) Monitor	Three (3) times weekly during operation hours

Surface Water:	at the five stations presently monitored, established for the Industrial Waste Permit, Approval No. 91-081.	Grab samples at mid-stream, mid-depth plus sediment samples, flow measurements of Bear Brook. Discharge volumes and quality from settlement ponds.	Monthly sampling of Bear Brook, plus sampling of Bear Brook when discharge from settlement ponds occurs. Analysis for RCAp.
Groundwater:	at the previously sampled (13) residential wells the Algas observation well and four other monitoring wells as shown in Figure 4-1.	Grab samples from as close to source as possible.	Four times per year for Analysis RCAp. Water levels in the four proposed monitoring wells to be measured 3 times/day during the first week of pumping and weekly there-after. Discharge will be measured.

Data Storage: By Westray or their consultants

Analysis: All data to be analyzed biweekly plus six months after the initiation of the mining operation to assess:

- any need to change locations of monitoring frequency and variables
- review any impacts identified by the date

Reportings: All data will be made available to the Liaison Committee and regulatory agencies biweekly.

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REFERENCES

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APPENDIX I

Flexcolour Material Safety Data Sheets

DEARBORN

Safety Data

 Version #: 3.00

MATERIAL SAFETY DATA SHEET: KLAR-AID 6433

1) PRODUCT IDENTIFICATION:
PRODUCT USE: FLOCCULANT/COAGULANT

MANUFACTURER:
DEARBORN CHEMICAL COMPANY LIMITED
3451 ERINDALE STATION ROAD
MISSISSAUGA, ONTARIO
L5C 2S9

EMERGENCY PHONE:
OFFICE HOURS: 416-279-2222
AFTER HOURS: 613-996-6666

TRANSPORTATION OF DANGEROUS GOODS CLASSIFICATION:
CORROSIVE LIQUID, NOS (POLYALUMINUM CHLORIDE)
8 (9.2) 1760 III
WHMIS CLASSIFICATION:
CLASS D DIVISION 2 SUBDIVISION B;
CLASS E

2) INGREDIENTS:

Chemical Name.	CAS #	TLV(mg/m3)	LD50
POLYALUMINUM CHLORIDE	1327-41-9	2	?IOC
	%RANGE=(30.0- 60.0)		
POLYQUATERNARY AMINE	25988-97-0	N/E	2000E
	%RANGE=(10.0- 30.0)		
WATER	7732-18-5	N/E	2000E
	%RANGE=(10.0- 30.0)		

3) PHYSICAL DATA:

Physical state.....LIQUID	Freezing point.(Deg.C)MINUS 0
Odour threshold.....N/D	Boiling point..(Deg.C)N/D
Specific gravity.....1.14	Vapour pressure.....N/D
Density.....N/D	Vapour density(air=1).N/D
pH.....2.5-3.5	Evaporation rate.....N/D
Solubility in water...COMPLETE	Coeff. of water/oil...N/D

Appearance and odour..
CLEAR, STRAW COLOURED LIQUID, ODOURLESS.

4) FIRE AND EXPLOSION HAZARD DATA:
CONDITIONS OF FLAMMABILITY:
NON-FLAMMABLE
EXTINGUISHING MEDIA:WATER X FOAM X CO2 X
Other : DRY CHEMICAL
SPECIAL PROCEDURES:
FIREFIGHTERS SHOULD WEAR SELF-CONTAINED BREATHING APPARATUS.
FLASH POINT: (Deg. C PMCC) >95
FLAMMABLE LIMITS IN AIR % BY VOLUME: LOWER N/D UPPER N/D
AUTO IGNITION TEMP: (Deg. C) N/D
HAZARDOUS COMBUSTION PRODUCTS:OXIDES OF CARBON
EXPLOSION DATA:
SENSITIVITY TO IMPACT.....(NONE KNOWN
SENSITIVITY TO STATIC DISCHARGES..(NONE KNOWN

5) REACTIVITY DATA:
STABILITY (NORMAL COND.) STABLE X UNSTABLE
CONDITIONS TO AVOID:
HEAT IN EXCESS OF 40 DEGREES C.
CONDITIONS OF REACTIVITY:
NONE.
INCOMPATIBILITY: (MATERIALS TO AVOID)
STRONG OXIDIZERS.
HAZARDOUS DECOMPOSITION PRODUCTS:
CO, CO2.

6) TOXICOLOGICAL PROPERTIES:
ROUTE OF ENTRY: SKIN CONTACT XABSORBED BY SKIN EYE CONTACT X
INHALATION INGESTION X
EFFECTS OF ACUTE EXPOSURE
MAY CAUSE DISCOMFORT, NAUSEA AND VOMITING IF INGESTED.
MAY CAUSE SKIN AND EYE IRRITATION.
EFFECTS OF CHRONIC EXPOSURE:
N/D

Oral rat LD50mg/Kg.(calc.):	>2000	Exposure limits:	N/D
Irritancy:	N/D	Sensitization:	N/D
Synergestic Mat.:	NONE KNOWN	Carcinogenicity:	NONE KNOWN
Reproductive Eff.:	NONE KNOWN	Teratogenicity:	NONE KNOWN
Mutaginicity:	NONE KNOWN		

7) PREVENTATIVE MEASURES
PERSONAL PROTECTIVE EQUIPMENT:
EYE PROTECTION:X GLOVES:X CLOTHING:X
RESPIRATORY PROTECTION:
NOT NORMALLY REQUIRED.
VENTILATION REQUIREMENTS:
MECHANICAL (GENERAL).
SPILL AND LEAK PROCEDURES:
CONTAIN, CAREFULLY NEUTRALIZE, SOAK UP ON INERT MATERIAL AND PLACE IN PROPER CONTAINERS FOR DISPOSAL ACCORDING TO LOCAL REQUIREMENTS. FLUSH REMAINDER TO DRAIN WITH EXCESS WATER.
WASTE DISPOSAL:
USE AN APPROVED CHEMICAL SCAVENGER SERVICE.
HANDLING PROCEDURES:
WEAR CHEMICAL GOGGLES, RUBBER GLOVES AND PERSONAL PROTECTIVE CLOTHING.
STORAGE REQUIREMENTS:
KEEP CONTAINERS TIGHTLY SEALED WHEN NOT IN USE. KEEP FROM TEMPERATURES EXCEEDING 40 DEGREES C.
SPECIAL HANDLING INFORMATION:
NONE.

8) FIRST AID MEASURES:
IF INGESTED, INDUCE VOMITING AND GET MEDICAL ATTENTION. IF ON SKIN, WASH WITH SOAP AND WATER. IF IN EYES, FLUSH WITH WATER FOR 15 MINUTES AND GET MEDICAL ATTENTION. LAUNDER CLOTHING BEFORE REUSE.

9) OTHER INFORMATION:
NONE.

10) PREPARATION INFORMATION

PREPARED BY: T.B.Erwin.
DEARBORN CHEMICAL CO.LTD.
P.O. BOX 3060 STATION A.
MISSISSAUGA ONTARIO. L5A 3T5

DATE PREP./REV. 1991/06/01
PRINT DATE: 1992.06.02
PHONE: 416-279-2222
FAX: 416-279-0020

N/D-No Data N/A-Not Applicable N/E-Not established <-Less >-Greater
A-Oral rat LD50 B-Oral rat LD low C-oral LD50/LD low other animal
D-Estimated 1000 E-Arbitrary 2000 F-Other Route Prefix C-Ceiling limit

MATERIAL SAFETY DATA SHEET: KLAR-AID 6440

1) PRODUCT IDENTIFICATION:
PRODUCT USE: LIQUID CATIONIC FLOCCULANT/COAGULANT

MANUFACTURER:
DEARBORN CHEMICAL COMPANY LIMITED
3451 ERINDALE STATION ROAD
MISSISSAUGA, ONTARIO
L5C 2S9

EMERGENCY PHONE:
OFFICE HOURS: 416-279-2222
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TRANSPORTATION OF DANGEROUS GOODS CLASSIFICATION:
CORROSIVE LIQUID, NOS (ALUMINUM SULPHATE)
8 (9.2) 1760 III
WHMIS CLASSIFICATION:
CLASS D DIVISION 2 SUBDIVISION B

2) INGREDIENTS:

Chemical Name.	CAS #	TLV(mg/m3)	LD50
CATIONIC POLYMERIZED TANNINS	1401-55-4	N/E	2000E
	%RANGE-(30.0- 60.0)		
ALUMINUM SULPHATE	10043-01-3	N/E	2000C
	%RANGE-(5.0- 10.0)		
WATER	7732-18-5	N/E	2000E
	%RANGE-(40.0- 70.0)		

3) PHYSICAL DATA:
Physical state.....LIQUID
Odour threshold.....N/D
Specific gravity.....1.14
Density.....N/D
pH.....1.5-2.5
Solubility in water...COMPLETE
Appearance and odour..
BROWN VISCOUS LIQUID, SWEET ODOUR.

Freezing point.(Deg.C)MINUS 3
Boiling point..(Deg.C)100
Vapour pressure.....N/D
Vapour density(air=1).N/D
Evaporation rate.....N/D
Coeff. of water/oil...N/D

4) FIRE AND EXPLOSION HAZARD DATA:
CONDITIONS OF FLAMMABILITY:
NON-FLAMMABLE
EXTINGUISHING MEDIA:WATER X FOAM X CO2 X
Other : DRY CHEMICAL

SPECIAL PROCEDURES:
USE EXTINGUISHING MEDIA APPLICABLE TO PRIMARY CAUSE OF FIRE
FLASH POINT: (Deg. C PMCC) >95
FLAMMABLE LIMITS IN AIR % BY VOLUME: LOWER N/D UPPER N/D
AUTO IGNITION TEMP: (Deg. C) N/D
HAZARDOUS COMBUSTION PRODUCTS:OXIDES OF NITROGEN
EXPLOSION DATA:
SENSITIVITY TO IMPACT.....:NONE KNOWN
SENSITIVITY TO STATIC DISCHARGE:..:NONE KNOWN

5) REACTIVITY DATA:
STABILITY (NORMAL COND.) STABLE X UNSTABLE
CONDITIONS TO AVOID:
HEAT.
CONDITIONS OF REACTIVITY:
N/D
INCOMPATIBILITY: (MATERIALS TO AVOID)
STRONG OXIDISERS, ACIDS AND ALKALIS.
HAZARDOUS DECOMPOSITION PRODUCTS:
OXIDES OF NITROGEN ON COMBUSTION.

6) TOXICOLOGICAL PROPERTIES:
ROUTE OF ENTRY: SKIN CONTACT xABSORBED BY SKIN EYE CONTACT X
INHALATION INGESTION X
EFFECTS OF ACUTE EXPOSURE
MAY IRRITATE EYES ON CONTACT. MAY IRRITATE SKIN ON PROLONGED CONTACT. MAY CAUSE NAUSEA AND VOMITING IF INGESTED.
EFFECTS OF CHRONIC EXPOSURE:
N/D

Oral rat LD50mg/Kg.(calc.):>2000		Exposure limits.....:	N/D
Irritancy.....:	N/D	Sensitisation.....:	N/D
Synergestic Mat.....:	NONE KNOWN	Carcinogenicity.....:	NONE KNOWN
Reproductive Eff.....:	NONE KNOWN	Teratogenicity.....:	NONE KNOWN
Mutaginicity.....:	NONE KNOWN		

7) PREVENTATIVE MEASURES
PERSONAL PROTECTIVE EQUIPMENT:
EYE PROTECTION:X GLOVES:X CLOTHING:X
RESPIRATORY PROTECTION:
NOT NORMALLY REQUIRED.
VENTILATION REQUIREMENTS:
MECHANICAL (GENERAL).
SPILL AND LEAK PROCEDURES:
CONTAIN, SOAK UP AND INCINERATE.
WASTE DISPOSAL:
USE AN APPROVED CHEMICAL SCAVENGER SERVICE.
HANDLING PROCEDURES:
WEAR SAFETY GLASSES, RUBBER GLOVES AND PERSONAL PROTECTIVE CLOTHING.
STORAGE REQUIREMENTS:
KEEP COOL. DO NOT ALLOW TO FREEZE.
SPECIAL HANDLING INFORMATION:
NONE.

8) FIRST AID MEASURES:
WASH WITH WATER. IF EYES AFFECTED, FLUSH WITH WATER AND GET MEDICAL ATTENTION. IF INGESTED, INDUCE VOMITING AND GET MEDICAL ATTENTION.

9) OTHER INFORMATION:
NONE.

10) PREPARATION INFORMATION

PREPARED BY: T.B.Erwin.
DEARBORN CHEMICAL CO.LTD.
P.O. BOX 3060 STATION A.
MISSISSAUGA ONTARIO. L5A 3T5
DATE PREP./REV. 1991/06/01
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N/D-No Data N/A-Not Applicable N/E-Not established <-Less >-Greater
A=Oral rat LD50 B=Oral rat LD low C=oral LD50/LD low other animal
D=Estimated 1000 E=Arbitrary 2000 F=Other Route Prefix C=Ceiling limit

APPENDIX 2

Water Quality Data from Domestic Wells

GROUNDWATER CHEMISTRY

Domestic Water Well Supply

A. Moulton

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	70	< 200 (aesthetic)
Potassium	mg/L	3	
Calcium	mg/L	55	
Magnesium	mg/L	8	
Alkalinity	mg/L	260	
Sulfate	mg/L	14	< 500 (aesthetic)
Chloride	mg/L	35.6	< 250 (aesthetic)
Silica	mg/L	13.6	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	<0.05	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	0.96	
Iron	mg/L	2.77	< 0.3 (aesthetic)
Manganese	mg/L	0.71	< 0.05 (aesthetic)
Copper	mg/L	<0.01	< 1.0 (aesthetic)
Zinc	mg/L	0.03	< 5.0 (aesthetic)
Colour	TCU	< 5	< 15 (aesthetic)
Turbidity	NTU	26.5	< 5 (if no disinfection)
Spec. conduct.	umhos/c	603	
pH	Units	7.5	6.5-8.5
Total Organic Carbon	mg/L	0.8	
Hardness	mg/L	170	
Bicarbonate	mg/L	259	
Carbonate	mg/L	0.71	
Ion Sum	mg/L	376	
Theor. Conduct.	umhos/c	509	
Cation Sum	mg/L	6.05	
Anion Sum	mg/L	6.16	
% Difference	%	1.66	
Langelier Index		-0.36	
Saturation pH	UNITS	7.14	

Groundwater Characteristics

Water Type: Fresh, Hard, Low Coloured, Na or K Bicarbonate

Parameters above GCDWQ: Iron, Manganese, Turbidity

Comments

Owner stated water was "hard, often coloured, and had an odour"

Undoes a water softener, sample obtained before softener unit

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)

mg/L = milligrams per litre, equivalent to parts per million

umhos/c = micromhos per centimetre

TCU = True Colour Units

NTU = Nephelometric Turbidity Units

Arthur Moulton

R.R. #3, New Glasgow, Nova Scotia

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
J. Dakens

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	33.6	< 200 (aesthetic)
Potassium	mg/L	3.6	
Calcium	mg/L	38	
Magnesium	mg/L	9.6	
Alkalinity	mg/L	170	
Sulfate	mg/L	13	< 500 (aesthetic)
Chloride	mg/L	33.8	< 250 (aesthetic)
Lithium	mg/L	13.9	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	<0.05	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	1.3	
Iron	mg/L	0.66	< 0.3 (aesthetic)
Manganese	mg/L	0.39	< 0.05 (aesthetic)
Copper	mg/L	<0.01	< 1.0 (aesthetic)
Zinc	mg/L	0.02	< 5.0 (aesthetic)
Colour	TCU		< 15 (aesthetic)
Turbidity	NTU	4.45	< 5 (if no disinfection)
Spec. conduct.	umhos/s	450	
pH	Units	7.4	6.5-8.5
Total Organic Carbon	mg/L	1.4	
Hardness	mg/L	164	
Bicarbonate	mg/L	170	
Carbonate	mg/L	0.4	
Ion Sum	mg/L	363	
Theor. Conduct.	umhos/s	454	
Cation Sum	mg/L	4.87	
Anion Sum	mg/L	4.60	
% Difference	%	2.81	
Langelier Index		-0.32	
Saturation pH	UNITS	7.92	

Groundwater Characteristics

Water Type: Fresh, Hard, Low Colour, Ca Bicarbonate

Parameters above GCDWQ: Manganese

Comments

None

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre, equivalent to parts per million
umhos/s = micromhos per centimetre
TCU = True Colour Units
NTU = Nephelometric Turbidity Units

John Dakens
R.R. #3, Waterville Road, Waterville, Nova Scotia
B0P 1A0

GROUNDWATER CHEMISTRY
Dunmore Water Well Supply
D. Kosnyk

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	86.2	< 200 (aesthetic)
Potassium	mg/L	3.2	
Calcium	mg/L	23.3	
Magnesium	mg/L	6.4	
Alkalinity	mg/L	240	
Sulfate	mg/L	13	< 500 (aesthetic)
Chloride	mg/L	16.5	< 250 (aesthetic)
Silica	mg/L	10	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	<0.05	(10.0 acute, 1.0 acute)
Ammonia	mg/L	1.9	
Iron	mg/L	0.02	< 0.3 (aesthetic)
Manganese	mg/L	0.03	< 0.05 (aesthetic)
Copper	mg/L	<0.01	< 1.0 (aesthetic)
Zinc	mg/L	<0.01	< 5.0 (aesthetic)
Colour	TCU		< 15 (aesthetic)
Turbidity	NTU	4.18	< 1 (if no disinfection)
Spec. conduct.	umhos/c	339	
pH	Units	7.9	6.5-8.5
Total Organic Carbon	mg/L	1	
Hardness	mg/L	84.5	
Bicarbonate	mg/L	130	
Carbonate	mg/L	1.10	
Ion Sum	mg/L	107	
Theor. Conduct.	umhos/c	333	
Cation Sum	mg/L	5.65	
Anion Sum	mg/L	5.50	
% Difference	%	0.71	
Langelier Index		-0.2	
Saturation pH	UNITS	8.1	

Groundwater Characteristics

Water Type: Fresh, Moderately Soft, Low Colour, Mix or K Bicarbonate
Parameters above GCDWQ: None

Comments

Owner noted that test drilling by WSDME across road turned water from well black (temporarily)

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre, equivalent to parts per million
umhos/c = micromhos per centimetre
TCU = True Colour Units
NTU = Nephelometric Turbidity Units

Darryl Kosnyk
P.O. Box 1987, Stellarton, Nova Scotia

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
R. Swan

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	10.3	< 200 (aesthetic)
Potassium	mg/L	2.7	
Calcium	mg/L	65.1	
Magnesium	mg/L	0.2	
Alkalinity	mg/L	170	
Sulfate	mg/L	11	< 500 (aesthetic)
Chlorids	mg/L	16	< 250 (aesthetic)
Silica	mg/L	14.8	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	<0.05	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	0.6	
Iron	mg/L	0.01	< 0.3 (aesthetic)
Manganese	mg/L	0.31	< 0.05 (aesthetic)
Copper	mg/L	<0.01	< 1.0 (aesthetic)
Zinc	mg/L	0.01	< 5.0 (aesthetic)
Colour	TCU	< 5	< 15 (aesthetic)
Turbidity	NTU	0.63	< 5 (if no disinfection)
Spec. conduct.	umhos/cm	415	
pH	Units	7.5	6.5-8.5
Total Organic Carbon	mg/L	1.8	
Hardness	mg/L	156	
Bicarbonate	mg/L	169	
Carbonate	mg/L	0.5	
Ion Sum	mg/L	233	
Theor. Conduct.	umhos/cm	456	
Cation Sum	mg/L	4.84	
Anion Sum	mg/L	4.88	
% Difference	%	0.47	
Langelier Index		-0.42	
Saturation pH	UNITS	7.92	

Groundwater Characteristics

Water Type: Fresh, Hard, Low Colour, Ca-Bicarbonate
Parameters above GCDWQ: Manganese

Comments

Uhlman water filtration unit. Sample collected before entering filtration unit

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre, equivalent to parts per million
umhos/cm = microsiemens per centimetre
TCU = True Colour Units
NTU = Nenglelometric Turbidity Units

Bonnie Swan
R.R. #3, Waterville, Nova Scotia

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
A. Preble

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	107	< 200 (aesthetic)
Potassium	mg/L	2.3	
Calcium	mg/L	6.2	
Magnesium	mg/L	<0.1	
Alkalinity	mg/L	100	
Sulfate	mg/L	14	< 500 (aesthetic)
Chloride	mg/L	10.1	< 250 (aesthetic)
Silica	mg/L	11.6	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	<0.01	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	1.62	
Iron	mg/L	<0.02	< 0.3 (aesthetic)
Manganese	mg/L	<0.01	< 0.05 (aesthetic)
Copper	mg/L	<0.01	< 1.0 (aesthetic)
Zinc	mg/L	<0.01	< 5.0 (aesthetic)
Colour	TCU	<3	< 15 (aesthetic)
Turbidity	NTU	0.30	< 5 (if no disinfection)
Spec. conduct	umhos	940	
pH	Units	7.7	6.5-8.5
Total Organic Carbon	mg/L	1	
Hardness	mg/L	83	
Bicarbonate	mg/L	120	
Carbonate	mg/L	1.20	
Ion Sum	mg/L	138	
Theor. Conduct	umhos/c	937	
Cation Sum	mg/L	9.19	
Anion Sum	mg/L	9.16	
% Difference	%	0.13	
Langelier Index		2.30	
Saturation pH	UNITS	10.1	

Groundwater Characteristics

Water Type: Fresh, Very Soft, Low Colour, Na or K Bicarbonate
Parameters above G(CDWQ): Total Dissolved Solids

Comments

Domestic treated water "hard". Water softener
unitized - sample obtained after softener

Notes

G(CDWQ) = Guidelines for Canadian Drinking Water Quality (1987)
mg/L = milligrams per litre, equivalent to parts per million
umhos/c = micromhos per centimetre
TCU = True Colour Units
NTU = Nephelometric Turbidity Units

Alastair Rourke
P.O. Box 390, Sicamous, British Columbia

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
S. Kinnock

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	1.32	< 200 (aesthetic)
Potassium	mg/L	3.4	
Calcium	mg/L	35.1	
Magnesium	mg/L	11.4	
Alkalinity	mg/L	160	
Sulfate	mg/L	41	< 500 (aesthetic)
Chloride	mg/L	6.6	< 250 (aesthetic)
Silica	mg/L	10.1	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	2.1	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	<0.05	
Iron	mg/L	<0.02	< 0.3 (aesthetic)
Manganese	mg/L	<0.01	< 0.05 (aesthetic)
Copper	mg/L	0.02	< 1.0 (aesthetic)
Zinc	mg/L	0.03	< 5.0 (aesthetic)
Colour	TCU	<5	< 15 (aesthetic)
Turbidity	NTU	0.43	< 5 (if no disinfection)
Spec. conduct.	umhos/c	331	
pH	Units	7.5	6.5-8.5
Total Organic Carbon	mg/L	0.9	
Hardness	mg/L	137	
Bicarbonate	mg/L	209	
Carbonate	mg/L	1.07	
Ion Sum	mg/L	466	
Theor. Conduct	umhos/c	630	
Cation Sum	mg/L	6.37	
Anion Sum	mg/L	6.30	
% Difference	%	1.06	
Langelier Index		-0.25	
Saturation pH	UNITS	7.75	

Groundwater Characteristics

Water Type: Fresh, Very Hard, Low Colour, Na or K Bicarbonate
Parameters above GCDWQ: None

Comments

Owner currently on Town of Stellarton water supply. Well water utilized frequently.

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1987)
mg/L = milligrams per litre, equivalent to parts per million
umhos/c = microhms per centimetre
TCU = True Colour Units
NTU = Nephelometric Turbidity Units

Steven Kinnock
R.R. #3, P.O. Box 33, New Glasgow, Nova Scotia
B2H 5E4

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
/ 6 / 5 Bears

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	114	< 200 (aesthetic)
Potassium	mg/L	3	
Calcium	mg/L	139	
Magnesium	mg/L	10.1	
Alkalinity	mg/L	148	
Sulfate	mg/L	28	< 500 (aesthetic)
Chloride	mg/L	330	< 250 (aesthetic)
Silica	mg/L	13.1	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	0.09	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	0.72	
Iron	mg/L	1.23	< 0.3 (aesthetic)
Manganese	mg/L	1.39	< 0.05 (aesthetic)
Copper	mg/L	<0.01	< 1.0 (aesthetic)
Zinc	mg/L	0.10	< 5.0 (aesthetic)
Colour	TCU	30	< 15 (aesthetic)
Turbidity	NTU	16.6	< 1 (if no disinfection)
Spec. conduct.	umhos/c	1430	
pH	Units	7.1	6.5-8.5
Total Organic Carbon	mg/L	1	
Hardness	mg/L	361	
Bicarbonate	mg/L	148	
Carbonate	mg/L	0.17	
Ion Sum	mg/L	723	
Theor. Conduct	umhos/c	1330	
Cation Sum	mg/L	13.1	
Anion Sum	mg/L	12.7	
% Difference	%	1.5	
Langelier Index		0.33	
Saturation pH	UNITS	7.63	

Groundwater Characteristics

Water Type: Fresh, Very Hard, Medium Coloured, Ca or Na Chloride
Parameters above GCDWQ: Chloride, Iron, Manganese, Colour, Turbidity
Total Dissolved Solids

Comments

Utilizes a water softener, sample obtained before softener. Owner
stated increased manganese content, decreased yield not after
drilling by MSDNRE completed.

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre, equivalent to parts per million
umhos/c = micromhos per centimetre
TCU = True Colour Units
NTU = Nephelometric Turbidity Units

Jack & Joyce Kilborn
P.O. #1, Box 73, R.R. #1
New Glasgow, Nova Scotia
B2H 5C6

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
C. MacDonald

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	14.2	< 200 (aesthetic)
Potassium	mg/L	1.4	
Calcium	mg/L	19.7	
Magnesium	mg/L	3.6	
Alkalinity	mg/L	58	
Sulfate	mg/L	9	< 500 (aesthetic)
Chloride	mg/L	31.6	< 250 (aesthetic)
Nitrite	mg/L	0.1	
Nitrate-Phosphate	mg/L	<0.60	
Nitrate+Nitrite	mg/L	0.69	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	<0.05	
Iron	mg/L	0.1	< 0.3 (aesthetic)
Manganese	mg/L	<0.00	< 0.05 (aesthetic)
Copper	mg/L	0.03	< 1.0 (aesthetic)
Zinc	mg/L	0.00	< 5.0 (aesthetic)
Colour	TCU		< 15 (aesthetic)
Turbidity	NTU	< 1	< 1 (if no disinfection)
Spec. conduct.	umhos/c	118	
pH	Units	6.3	6.5-8.5
Total Organic Carbon	mg/L	1	
Hardness	mg/L	63.2	
Bicarbonate	mg/L	38	
Carbonate	mg/L	0.61	
Ion Sum	mg/L	117	
Theor. Conduct.	umhos/c	213	
Cation Sum	mg/L	1.42	
Anion Sum	mg/L	1.66	
% Difference	%	1.31	
Langelier Index		2.44	
Saturation pH	Units	9.79	

Groundwater Characteristics

Water Type: Fresh, Moderately Soft, Low Colour, No Dissolved Type
Parameters above GCDWQ: None

Comments

Utilizes a water softener.

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1996)
mg/L = milligrams per litre, equivalent to parts per million
umhos/c = microsiemens per centimetre
TCU = True Colour Units
NTU = Nephelometric Turbidity Units

Cole MacDonald
P.O. Box 665, Port Oregon, Nova Scotia
B3H 1E7

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
L. Gosbee

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	76.9	< 200 (aesthetic)
Potassium	mg/L	2.2	
Calcium	mg/L	14.3	
Magnesium	mg/L	4.2	
Alkalinity	mg/L	130	
Sulfate	mg/L	6	< 500 (aesthetic)
Chloride	mg/L	55.7	< 250 (aesthetic)
Silica	mg/L	13.3	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	<0.05	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	0.97	
Iron	mg/L	2.74	< 0.3 (aesthetic)
Manganese	mg/L	0.36	< 0.05 (aesthetic)
Copper	mg/L	<0.01	< 1.0 (aesthetic)
Zinc	mg/L	<0.01	< 5.0 (aesthetic)
Colour	TCU		< 15 (aesthetic)
Turbidity	NTU	29.2	< 5 (if no disinfection)
Spec. conduct.	umhos/c	469	
pH	Units	7	6.5-8.5
Total Organic Carbon	mg/L	1	
Hardness	mg/L	53	
Bicarbonate	mg/L	130	
Carbonate	mg/L	0.12	
Ion Sum	mg/L	252	
Theor. Conduct.	umhos/c	468	
Cation Sum	mg/L	4.53	
Anion Sum	mg/L	4.3	
% Difference	%	2.66	
Langelier Index		-1.58	
Saturation pH	UNITS	8.58	

Groundwater Characteristics

Water Type: Fresh, Soft, Low Colour, Na or K Bicarbonate
Parameters above GCDWQ: Iron, Manganese, Turbidity

Comments

Owner noted high iron content, oil film/odour from water

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre; equivalent to parts per million
umhos/c = micromos per centimetre
TCU = True Colour Units
NTU = Neophelometric Turbidity Units

Lawson Gosbee
R.R. #3, New Glasgow, Box 21, Site 9
New Glasgow, Nova Scotia

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
R. Priest

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	11.5	< 200 (aesthetic)
Potassium	mg/L	1.4	
Calcium	mg/L	19.7	
Magnesium	mg/L	3.5	
Alkalinity	mg/L	46	
Sulfate	mg/L	10	< 500 (aesthetic)
Chloride	mg/L	25.3	< 250 (aesthetic)
Silica	mg/L	9.3	
Ortho Phosphate	mg/L	<0.01	
Nitrate+Nitrite	mg/L	0.24	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	<0.05	
Iron	mg/L	0.03	< 0.3 (aesthetic)
Manganese	mg/L	<0.01	< 0.05 (aesthetic)
Copper	mg/L	1.4	< 1.0 (aesthetic)
Zinc	mg/L	0.15	< 5.0 (aesthetic)
Colour	TCU	<3	< 15 (aesthetic)
Turbidity	NTU	0.17	< 5 (if no disinfection)
Spec. conduct.	umhos/c	201	
pH	Units	6.3	6.5-8.5
Total Organic Carbon	mg/L	0.7	
Hardness	mg/L	63.6	
Bicarbonate	mg/L	46	
Carbonate	mg/L	0.01	
Ion Sum	mg/L	109	
Theor. Conduct.	umhos/c	203	
Cation Sum	mg/L	1.81	
Anion Sum	mg/L	1.86	
% Difference	%	1.39	
Langelier Index		-2.56	
Saturation pH	UNITS	8.86	

Groundwater Characteristics

Water Type: Fresh, Moderately Soft, Low Colour, Ca Bicarbonate
Parameters above GCDWQ: Iron, Manganese, Turbidity

Comments

Owner noted swampy odour. Water from well not used for drinking purposes.

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre; equivalent to parts per million
umhos/c = micromos per centimetre
TCU = True Colour Units
NTU = Neophelometric Turbidity Units

Russell Priest
R.R. #3, Box 5, New Glasgow, Nova Scotia
B2H 5C6

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
H. MacKay

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	70.5	< 200 (aesthetic)
Potassium	mg/L	1.7	
Calcium	mg/L	16.2	
Magnesium	mg/L	4	
Alkalinity	mg/L	130	
Sulfate	mg/L	32	< 500 (aesthetic)
Chloride	mg/L	26.7	< 250 (aesthetic)
Silica	mg/L	12.1	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	0.38	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	0.16	
Iron	mg/L	0.09	< 0.3 (aesthetic)
Manganese	mg/L	0.03	< 0.05 (aesthetic)
Copper	mg/L	<0.01	< 1.0 (aesthetic)
Zinc	mg/L	0.01	< 5.0 (aesthetic)
Colour	TCU	<3	< 15 (aesthetic)
Turbidity	NTU	1.99	< 5 (if no disinfection)
Spec. conduct.	umhos/c	432	
pH	Units	7.6	6.5-8.5
Total Organic Carbon	mg/L	0.6	
Hardness	mg/L	56.9	
Bicarbonate	mg/L	129	
Carbonate	mg/L	0.48	
Ion Sum	mg/L	243	
Theor. Conduct.	umhos/c	434	
Cation Sum	mg/L	4.26	
Anion Sum	mg/L	4.05	
% Difference	%	2.57	
Langelier Index		-0.92	
Saturation pH	UNITS	8.52	

Groundwater Characteristics

Water Type: Fresh, Soft, Low Colour, Na or K Bicarbonate
Parameters above GCDWQ: None

Comments

Owner stated sulphur smell from water.

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre; equivalent to parts per million
umhos/c = micromos per centimetre
TCU = True Colour Units
NTU = Neophelometric Turbidity Units

Helen MacKay
R.R. #3, Box 10, New Glasgow, Nova Scotia
B2H 5C6

GROUNDWATER CHEMISTRY

Domestic Water Well Supply
C. Roddick

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	11.5	< 200 (aesthetic)
Potassium	mg/L	1.4	
Calcium	mg/L	19.7	
Magnesium	mg/L	3.5	
Alkalinity	mg/L	46	
Sulfate	mg/L	10	< 500 (aesthetic)
Chloride	mg/L	25.3	< 250 (aesthetic)
Silica	mg/L	9.3	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	0.24	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	<0.05	
Iron	mg/L	0.03	< 0.3 (aesthetic)
Manganese	mg/L	<0.01	< 0.05 (aesthetic)
Copper	mg/L	1.4	< [illegible] thetic)
Zinc	mg/L	0.15	< [illegible] etic)
Colour	TCU	<3	< [illegible] netic)
Turbidity	NTU	0.17	< 5 (if no disinfection)
Spec. conduct.	umhos/c	201	
pH	Units	6.3	6.5-8.5
Total Organic Carbon	mg/L	0.7	
Hardness	mg/L	63.6	
Bicarbonate	mg/L	46	
Carbonate	mg/L	0.01	
Ion Sum	mg/L	109	
Theor. Conduct.	umhos/c	203	
Cation Sum	mg/L	1.81	
Anion Sum	mg/L	1.86	
% Difference	%	1.39	
Langelier Index		-2.56	
Saturation pH	UNITS	8.86	

Groundwater Characteristics

Water Type: Fresh, Moderately Soft, Low Colour, Ca Bicarbonate
Parameters above GCDWQ: pH

Comments

Owner stated frequent water shortage recently.

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre; equivalent to parts per million
umhos/c = micromos per centimetre
TCU = True Colour Units
NTU = Neophelometric Turbidity Units

Carolyn Roddick
R.R. #3, Westville, Nova Scotia

GROUNDWATER CHEMISTRY
Domestic Water Well Supply
T. Kirinicich

PARAMETER	UNITS	RESULTS	Guidelines For Canadian Drinking Water Quality
Sodium	mg/L	107	< 200 (aesthetic)
Potassium	mg/L	5.3	
Calcium	mg/L	50.5	
Magnesium	mg/L	14.2	
Alkalinity	mg/L	320	
Sulfate	mg/L	80	< 500 (aesthetic)
Chloride	mg/L	6.2	< 250 (aesthetic)
Silica	mg/L	6.6	
Ortho Phosphate	mg/L	<0.01	
Nitrate + Nitrite	mg/L	0.6	(10.0 nitrate, 1.0 nitrite)
Ammonia	mg/L	2.3	
Iron	mg/L	<0.02	< 0.3 (aesthetic)
Manganese	mg/L	0.05	< 0.05 (aesthetic)
Copper	mg/L	0.02	< 1.0 (aesthetic)
Zinc	mg/L	1.88	< 5.0 (aesthetic)
Colour	TCU	<3	< 15 (aesthetic)
Turbidity	NTU	0.39	< 5 (if no disinfection)
Spec. conduct.	umhos/c	814	
pH	Units	7.5	6.5-8.5
Total Organic Carbon	mg/L	1.5	
Hardness	mg/L	185	
Bicarbonate	mg/L	319	
Carbonate	mg/L	0.95	
Ion Sum	mg/L	467	
Theor. Conduct.	umhos/c	854	
Cation Sum	mg/L	8.64	
Anion Sum	mg/L	8.28	
% Difference	%	2.14	
Langelier Index		-0.16	
Saturation pH	UNITS	7.66	

Groundwater Characteristics

Water Type: Fresh, Very Hard, Low Colour, Na or K Bicarbonate
Parameters above GCDWQ: None

Comments

Owner currently on Town of Stellarton water supply. Well water utilized infrequently.

Notes

GCDWQ = Guidelines for Canadian Drinking Water Quality (1989)
mg/L = milligrams per litre; equivalent to parts per million
umhos/c = micromos per centimetre
TCU = True Colour Units
NTU = Neophelometric Turbidity Units

Tom Kirincich
79 Foster Ave.
New Glasgow, Nova Scotia

APPENDIX 3

Public Attitude Survey

Public Opinion Research
June, 1992

by
Omnifacts Research Limited

#
92110

INTRODUCTION

A public opinion telephone survey was undertaken by Omnifacts Research to determine public sentiment towards the development of an open-pit coal mine in Stellarton, Nova Scotia.

Interviewing commenced on June 28, 1992 from Omnifacts' central telephone facility in Dartmouth, Nova Scotia. Interviewing was completed on June 30th, 1992. In total, 431 interviews were completed. Respondents were selected at random from the New Glasgow telephone listings. This exchange includes New Glasgow, Stellarton, Plymouth, Westville, Trenton and several smaller communities in the immediate area. A copy of the final questionnaire is included as Appendix A to this report.

CONCLUSIONS

The majority of the sample (53%) are in favour of the development of an open-pit mine in Stellarton to mine coal. Females (44% favour) and those in the lowest income category (42% favour) were the least likely to favour the development. **Overall, those in favour of the development outnumber those opposed by a margin of two to one.**

Motivation for favouring the development of the mine is based almost exclusively on the feeling that jobs are needed in the local economy. The opening question on the survey supports the conclusion that economic issues clearly dominate the issues facing Nova Scotia today.

Several reasons were given for opposition to the development. These included dust/pollution (52% of those opposed to the development mentioned this reason), safety concerns for the miners (49%) and the appearance of the mine (48%). However, when asked for the main reason for their opposition, 43% mentioned safety concerns for the miners. This is undoubtedly at least partly related to the recent explosion in Plymouth.

SAMPLE CHARACTERISTICS

The sample characteristics are shown in the following tables. In total, 431 interviews were completed and the sample was evenly divided between males and females. Just over one third of the sample (36%) was 34 years old or younger and 42% were over 45. Over 60% of the sample (61%) had completed high school or less.

Household incomes were fairly evenly divided between the categories that were presented. Ten percent of the sample reported household incomes under $10,000 a year and 17% reported incomes in excess of $50,000 a year. The proportion of the sample coming from each of the communities included in the research is basically in line with the populations in those communities. Thirty-seven percent of the sample is from New Glasgow, reflecting that town's larger size. Twenty percent were from Westville and 18% were from Stellarton. Only two percent are from Plymouth. The locations included in the "other" category were the remaining small communities in the immediate area that were included in the New Glasgow telephone exchange.

Sample Characteristics

	n	%
TOTAL SAMPLE (n)	431	100
Gender		
Male	215	50
Female	216	50
Age		
18-24	56	13
25-34	101	23
35-44	89	21
45-54	57	13
55 and over	127	29
Refused	1	0
Level of Education		
Elementary/ Some High School	138	32
Completed High School	124	29
Community College/ Vocational/Trades	70	16
Some University	38	9
Completed University	58	13
No formal Schooling	1	+
DK/Refused	2	+
Household Income		
Under $10,000	43	10
$10,000 to 19,000	69	16
$20,000 to 29,000	63	15
$30,000 to 39,000	73	17
$40,000 to 49,000	38	9
$50,000 or over	72	17
Refused	73	17
Town or Community		
New Glasgow	158	37
Westville	87	20
Stellarton	76	18
Trenton	45	10
Plymouth	10	2
Other	55	13

+ Less than 0.5%

MOST IMPORTANT ISSUE

The questionnaire began with a general question asking respondents what they considered the most important issue facing Nova Scotia today. Responses were not read to respondents in this case and only one response was permitted.

Q.1 In your view, what do you consider to be the most important issue facing Nova Scotia today?

	n	%
TOTAL SAMPLE (n)	431	100
Unemployment/loss of jobs	249	58
Poor economy/recession	70	16
Environment/pollution	28	6
Politics	8	2
School funding	8	2
Fisheries/Plant closures	6	1
Future of Canada/ National unity	6	1
Poor Government leadership	6	1
Mine closure	5	1
Violence in Nova Scotia	3	1
Other	15	3
DK/NA	27	6

The dominance of economic issues is immediately clear from the table. Unemployment/loss of jobs was the most frequently given answer (58%) and a similar answer, poor economy/recession was mentioned by 16%. Three quarters of the sample consider economic issues to be the most important ones facing Nova Scotia.

This same question is included every six months on the *Omnifacts Atlantic Report* for Nova Scotia as a whole. Our recent data mirrors these findings in that economic issues are clearly dominating the various issues that face the province.

STELLARTON OPEN-PIT MINE

The questioning next moved to the issue of the development of an open-pit mine in Stellarton, Nova Scotia. Respondents were asked if they favoured or opposed the development and then the strength of their feelings. The tables that are included show the results for the whole sample and the results of the cross-tabulations that were statistically significant. Cross-tabulations were run for all of the demographic variables and **there were no significant differences by community, age or by education level**. This means support was equally favourable across communities, age groups and those of the various education levels.

Q.2 There has been some discussion lately of developing an open-pit mine in Stellarton, Nova Scotia to mine coal. Which of the following best describes how you feel about the development of an open-pit coal mine in Stellarton? Do you ..... the development of such a mine?

	TOTAL	Strongly favour	Somewhat favour	Neither favour nor oppose	Somewhat oppose	Strongly oppose
TOTAL SAMPLE (n)	431	20%	33%	19%	12%	15%
** Gender						
Male	215	27%	36%	16%	11%	9%
Female	216	13%	31%	23%	13%	20%
* Household income						
Under $10,000	43	12%	30%	9%	12%	37%
$10,000 to 19,000	69	26%	32%	12%	13%	17%
$20,000 to 29,000	63	19%	32%	27%	13%	10%
$30,000 to 39,000	73	23%	34%	27%	10%	5%
$40,000 to 49,000	38	16%	32%	24%	16%	13%
$50,000 or over	72	25%	32%	17%	13%	14%
Refused	73	16%	40%	19%	10%	15%

* Interaction significant at $p < .05$
** Interaction significant at $p < .001$

In total, 20% of the sample strongly favoured the development of an open-pit mine in Stellarton and 33% were somewhat in favour with the concept (53% favour the development). Fifteen percent were strongly opposed to the development and an additional 12% were somewhat opposed. Ninteen percent were neither in favour nor opposed to the development. Therefore, those in favour of the development outnumber those opposed **by a margin of two to one** (53% compared with 27% opposed).

The cross-tabulations show a significant difference based on gender and one based on household income. Males, (63% favour) were much more likely to favour the development than were females (44% favour). Interestingly, those in the lowest income group were less likely to favour

the development (42% of those in the under $10,000 category) than were the people in the other income categories. Those earning under $10,000 were also the people who were most likely to strongly oppose the development (37%). They were more concerned about miner safety than the rest of the sample.

Those who were in favour of the open-pit mine development were asked why they felt that way. The strong majority of these people (89%) were motivated by the need for jobs in the local economy. Thirty-one percent felt that an open-pit mine would address safety concerns related to sub-surface mining.

Q.3 Why do you favour the development of an open-pit mine in Stellarton?

(Subsample: Those in favour of mine)

	n	%
TOTAL SAMPLE (n)	232	100
Jobs/Local economy	207	89
Safety concerns addressed	72	31
Land is reuseable after it's over	4	2
Resource to be utilized	4	2
Other	8	3

Those who were opposed to the development were also asked for their reasons. Their responses are shown below and approximately half of these people mentioned concerns over each of dust/pollution, safety concerns for miners and the appearance of the development.

Q.4 Why are you opposed to the development of an open-pit mine in Stellarton?

(Subsample: Those opposed to mine)

	n	%
TOTAL SAMPLE (n)	115	100
Dust/Pollution	60	52
Noise	22	19
Safety concerns for miners	56	49
Property values	35	30
Eyesore/Appearance	55	48
Westray connected	2	2
Don't want any more dissasters	2	2
Roads poor due to truck traffic	2	2
Other	12	10
Don't know	1	1

In order to more clearly isolate the reasons for opposition, those opposed to the development were asked for the one main reason for their opposition. Interestingly, the reason that was mentioned by most was safety concerns for the miners (43%). This was followed by the appearance of the mine (23%) and by pollution concerns (18%).

Q.5 Which of the reasons you just gave me is the main reason for your opposition to the open-pit mine in Stellarton?

(Subsample: Those opposed to mine)

	n	%
TOTAL SAMPLE (n)	*115*	*100*
Safety concerns for miners	*50*	*43*
Eyesore/Appearance	*26*	*23*
Dust/Pollution	*21*	*18*
Property values	*9*	*8*
Other	*8*	*7*
Don't know	*1*	*1*

Appendix A

Questionnaire

Job # 92110 **Questionnaire** June, 1992

Good day/evening, my name is _____ and I am calling from Omnifacts Research Limited, a professional research firm located in Dartmouth. Today we are conducting a short survey on issues that are important to your community. I would like to speak with someone eighteen years of age or older who's birthday comes next after today. **If that person is not available, arrange a time to call back and re-introduce if necessary.** Would you have 3 or 4 minutes to complete the survey with me?

1. In your view, what do you consider to be the most important issue facing Nova Scotia today? **DO NOT READ - CODE ONE ONLY**

Unemployment/loss of jobs (general)	01	____
Mine Clossure	02	
Fisheries/Plant closures	03	
Future of Canada/National Unity	04	
Environment/Pollution	05	
Poor economy/recession	06	
Other **(VOL) (SPECIFY)** _____		
DK/NA	99	

2. There has been some discussion lately of developing an open-pit mine in Stellarton, Nova Scotia to mine coal. Which of the following best describes how you feel about the development of an open-pit coal mine in Stellarton? Do you **READ CHOICES** the development of such a mine?

Strongly favour	1	**GO TO Q.3** ____
Somewhat favour	2	**GO TO Q.3**
Neither favour nor oppose	3	**GO TO Q.6**
Somewhat oppose	4	**GO TO Q.4**
Strongly oppose	5	**GO TO Q.4**

3. **[IF IN FAVOUR]** Why do you favour the development of the open-pit mine in Stellarton? **PROBE AND RECORD ALL ANSWERS BELOW - DO NOT READ**

Jobs/Local Economy	1	____
Safety Concerns addressed	1	____
Other _____		

GO TO Q.6

4. **[IF OPPOSED]** Why are you opposed to the development of the open-pit mine in Stellarton? **DO NOT READ - PROBE**

Dust/Pollution	1	____
Noise	1	____
Safety Concerns for miners	1	____
Property Values	1	____
Eyesore/Appearance	1	____
Other _____		

5. Which of the reasons you just gave me is the main reason for your opposition to the open-pit mine in Stellarton? **CIRCLE ONE RESPONSE BELOW**

Dust/Pollution	1	____
Noise	2	
Safety Concerns for miners	3	
Property Values	4	
Eyesore/Apearance	5	
Other _____		

And just to finish, we have a few questions to help us to classify the information you have provided. Please be assured that all of your answers will be kept entirely confidential.

6. Into which of the following age categories may I place you?

18 - 24	1	____
25 - 34	2	
35 - 44	3	
45 - 54	4	
55 and over	5	
Refused	9	

7. What is the highest level of education you have had an opportunity to obtain?
DO NOT READ

Elementary/Some High School (1-11)	1	____
Completed High School (12)	2	
Community College/Vocational/Trades	3	
Some University	4	
Completed University	5	
No formal schooling	6	
DK/Refused	9	

8. For statistical purposes, we need information about your household income. Please tell me which category applies to your total household income for 1991?

Under $10,000	1	____
$10,000 - $19,999	2	
$20,000 - $29,999	3	
$30,000 - $39,999	4	
$40,000 - $49,999	5	
$50,000 or over	6	
Refused	9	

9. Finally, may I have the name of your town or community?

New Glasgow	1	____
Stellarton	2	
Plymouth	3	
Westville	4	
Trenton	5	
Other _____	6	

(RECORD OTHER)

10. **Observe Gender**

Male	1	____
Female	2	

Confirm Telephone Number: _____

THANK YOU FOR YOUR HELP

Interviewer #: _____ ____

Date: _____

Supervisor: _____